SCIENCE EDUCATION

Formerly GENERAL SCIENCE QUARTERLY

SERVING TEACHERS IN ELEMENTARY SCHOOLS, JUNIOR AND SENIOR HIGH SCHOOLS, COLLEGES, AND PROFESSIONAL SCHOOLS FOR TEACHERS

VOLUME 37 FEBRUARY, 1953 NUMBER 1

CONTENTS

(The Contents of SCIENCE EDUCATION are indexed in the Education Index)

SCIENCE EDUCATION

VOLUME 37 FEBRUARY, 1953 NUMBER 1

J. DARRELL BARNARD
Professor of Education, New York University

J. DARRELL BARNARD

Dr. J. Darrell Barnard, Professor of Education and Chairman of the Department of Science Education, School of Education, New York University, was elected twentieth president of the National Association for Research in Science Teaching at the Silver Anniversary Meeting in Chicago. He will preside at the meetings in Atlantic City in 1953. He succeeds Dr. Betty Lockwood Wheeler.

Dr. Barnard was born in Johnstown, Colorado, on April 20, 1906. His academic work includes majors in biology and science education at Colorado State College of Education and a Ph.D. degree from New York University in 1941.

Teaching experience includes rural elementary school, 1926–1929; Superintendent of Schools, Galeton, Colorado from 1931 to 1934; and at Ault, Colorado from 1934–1936; Supervising Teacher of Science, College High School, Colorado State College of Education from 1936 to 1938; Teaching Fellow at New York University, 1938 to 1940.

Dr. Barnard formerly served as Chairman of the Division of Sciences and Mathematics at the Colorado State College of Education, Greeley, Colorado. He served as an executive officer with the U. S. Air Force, 1942 to 1945. During 1945 and 1946, he was an officer in charge of teacher education with the staff of the Supreme Commander of the Allied Powers in Japan.

Dr. Barnard is a member of Phi Delta Kappa, Kappa Delta Pi, Lambda Sigma Tau, National Association for Research in Science Teaching, National Educational Association, American Association for the Advancement of Science, National Science Teachers Association, and American Educational Research Association. He has served as educational consultant with the W. K. Kellogg Foundation.

Dr. Barnard's publications include articles in *Science Education,* the *N.E.A. Journal, Educational Method,* and *Journal of Educational Sociology*. He is co-author (with Edwards) of *Basic Science* published by the Macmillan Company and a contributor to *New High School in the Making* by Wrinkle and *Community Workshops,* a University of Michigan Monograph.

Dr. Barnard's present major interest is the relationship of problem-solving techniques to the teaching of science in the elementary and secondary schools.

Dr. Barnard is recognized as one of our best thinkers in the science education field. His accomplishments as teacher, writer, and organizer have made him a recognized leader among science education workers. He has shown especial leadership in planning and organizing science curriculum materials. He has been able to secure excellent cooperation among his fellow workers both locally and in national committees. He is the type of person you like to work with on committees and in conferences. Indeed NARST is very fortunate to have as its present president a leader of such noted past accomplishments and with every promise of greater accomplishments in the days ahead.

WALTER GEORGE WHITMAN

WALTER GEORGE WHITMAN

It is with sincere and deep regret that we record the passing of Walter George Whitman, founder and first editor of *General Science Quarterly,* now *Science Education.* Mr. Whitman suffered a heart attack at his home in Orlando, Florida, in October, shortly after his and Mrs. Whitman's return from a summer in the North. He died on November 2, 1952. He is survived by his wife, Mrs. Grace Bates Whitman and three children, George B. Whitman, Paris, France; Mary C. Whitman, Professor of Philosophy of the University of Buffalo; and H. Carlton Whitman, Orlando, Florida. Mr. Whitman was born in Norway, Maine, May 4, 1874. He had an A.B. degree from Tufts College, Medford, Massachusetts, (1898), and an M.A. degree from Columbia University, (1906).

Teaching experience of Mr. Whitman included Goddard Seminary, Barre, Vermont, 1898–1899; Gloucester, Massachusetts, High School, 1899–1903; Springfield Massachusetts, High School, 1903–1905; Ethical Culture School, New York City, 1905–1910; Head of Science Department, Massachusetts Normal School, Salem, Massachusetts, 1915–1944; Nanking University, China, 1925–26; summer schools (Columbia, 1906–12; Teachers College, Columbia University, 1913; Massachusetts State Normal School, Hyannis, Massachusetts, 1915–16; University of Pittsburgh, 1917–19; Hampton, Virginia, Normal and Agricultural Institute, 1924–25, 1927). He served as science editor for the American Book Company, 1913–15.

Mr. Whitman was a charter member of the National Association for Research in Science Teaching. He served as its vice-president in 1936 and as its president in 1937. Mr. Whitman was organizer of the General Science Club of New England, serving as its first president, 1916–18. He was president of the National Council on Elementary Science, 1934–35; president of the New England Association of Chemistry Teachers, 1912–13; vice-president of the New York City Physics Club, 1910. He was a member of a number of other organizations such as the American Association for the Advancement of Science, American Science Teachers Association, and so on.

Mr. Whitman was the author and co-author of a number of science textbooks and manuals. For many years these books were probably the best known and widely used of any similar textbooks in their respective fields. His *Household Physics,* published by John Wiley and Sons, was at one time very popular. He was co-author (with R. Williams) of *Laboratory Manual in Chemistry;* co-author (with George W. Hunter) of *Civic Science in the Home, Civic Science in the Community, My Own Science Problems, Science in Our Social Life, Science in Our World of Progress, Doorsteps to Science,* and *Problems in General Science;* co-author (with A. P. Peck) of *High School Physics* (all of these books had accompanying laboratory manuals and teacher guides), and all were published by the American Book Company. In 1927, Mr. Whitman prepared the scenarios for two science films for the Eastman Kodak Company, *Atmospheric Pressure* and *Compressed Air.*

Mr. Whitman was founder of *General Science Quarterly* in 1916 and served as Editor until 1931 (assuming complete responsibility for all work connected with its publication). He served again as temporary editor of *Science Education* in 1943–44. During this time he contributed a series of articles to *General Science Quarterly* and other publications.

When a final evaluation is made of the science teaching of the first half of the Twentieth Century, the contributions made by Walter George Whitman will assume a most important niche. His classroom teaching covered a span of nearly half a century, his secondary and college students each numbering in the thousands. His effect on these many contacts and in turn their effect on the teaching of science naturally cannot

be properly evaluated. A second important contribution came through the series of science textbooks used by many thousands of students in this country and abroad. For many years this series of books were recognized as the best and were the most widely used general science textbooks in the field. Surely the lives of countless students were influenced through their use.

A third major contribution has been the influence exerted on science teaching by *General Science Quarterly* and *Science Education* while Mr. Whitman served as Editor and Publisher He never lost interest in the work of *Science Education* after relinquishing active control. He was always one of its most loyal friends and supporter, an attitude much appreciated by the present editor. His work and contributions as Editor have long been recognized as outstanding by teachers and research workers in the field of science education. Because of his textbooks and work on *General Science Quarterly*, the writer would rank Mr. Whitman among the first five leaders in general science education of the first three decades or so of this century. Science education leaders will long remember the contributions made by this outstanding pioneer in general science education and research.

WARD T. FLETCHER

It is with regret that we report the passing of NARST member Professor Ward T. Fletcher, Florida State University, Tallahassee, Florida. Professor Fletcher died of a heart attack August 10, 1952. He was born at Greensboro, Florida, July 1, 1907.

Surviving are his wife, Mrs. Lois Lyman Fletcher and four children, Maxine 18, Sandra 15, Lyman 11, and David 8.

Doctor Fletcher had a B.S. degree from the University of Florida, an M.S. degree from Duke University, and a doctor's degree from Teachers College, Columbia University. Teaching experience included teaching science and assistant principal, Leon High School, Tallahassee 1929–1933; critic teacher in mathematics at Florida State College for Women, Tallahassee 1933–1941; Florida State University, 1947–1952, in charge of all testing for Florida State University and teaching courses in physical science and elementary science methods.

Dr. Fletcher served in World War II from 1941 to 1947—attaining the rank of Lt. Colonel. Six of these years was teaching mathematics at West Point and in summer field work, camps, and maneuvers.

Dr. Fletcher was a member of Kappa Delta Pi and Phi Delta Kappa. Writings included the Florida School Bulletin and unpublished work on his doctorate at Columbia University "Resource Use as Related to Science Education in Florida with Particular Reference to the Natural Land Resources as Related to Quantity and Quality of Food Production."

VERNON S. CULP

It was with great regret that we learned of the passing of Vernon S. Culp, a long time member of The National Association for Research in Science Teaching. Mr. Culp died of a heart attack on his way home in a car from school on December 15, 1952. Mr. Culp was born at Nappanee, Indiana on September 6, 1889. Surviving are his wife Sylvia E. Miller Culp, two children, Eugene M. Culp of Astoria, New York, Mrs. Julia E. Marston of Chatham, New Jersey, and four grandchildren.

Mr. Culp had a bachelor's degree from Goshen College (Indiana) and a master's degree from Indiana University. He also studied at the University of Akron, Ohio State University, and Western Reserve University. His teaching experience in-

cluded Freeman Junior College, Freeman, South Dakota; South High School, Akron, Ohio; two summers at Kent State University, Kent, Ohio; and West High School, Akron, Ohio. He had taught chemistry, physics, and photography since he first went there in 1916. Since 1929 he had been boys' counselor at West High. Mr. Culp had long been recognized by his associates and students as an unusually fine teacher of high school science.

Mr. Culp helped to organize the North East Ohio Chemistry Teachers Association and was a charter member. He served as its secretary-treasurer for many years. He also served as its president and was secretary at the time of his death. He was also a charter member of the Akron Section of the American Chemical Society.

Mr. Culp was also a member of the National Science Teachers Association, Ohio Chemistry Teachers Association, American Association for the Advancement of Science, Ohio Academy of Science, and a number of other educational and local organizations.

GENERAL SCIENCE QUARTERLY—SCIENCE EDUCATION *

CLARENCE M. PRUITT

THIS is the story of the birth of this magazine, which was started in 1916 by Walter G. Whitman. While he was teaching physics and chemistry in Springfield, Massachusetts, in 1903–05, a change was made in the science for the first year high school pupils. The freshman science had been a course in biology that, either from the subject matter given or the method employed, was extremely uninteresting to the pupils. At this time Russell and Kelly introduced a "First Year Science" in the nature of general science. This was a success from the start.

The majority of the New England chemistry and physics teachers who had fluorishing organizations looked with disfavor upon this new type of elementary science. Being steeped in the traditional ideas of the New England chemistry teachers and physics teachers, Whitman paid little attention to the first-year science idea at that time. Very few schools in New England were doing anything in the nature of general science. However, it was growing rapidly in popularity in some parts of the country.

In 1913 Whitman accepted a temporary position with the American Book Company as editor covering the entire field of science. His teaching had been chiefly in the fields of chemistry and physics. To a less degree he had taught botany, physical geography, and geology. One of his first jobs as science editor was the preparation of Bertha Clark's manuscript, *Laboratory Manual in General Science,* for the printer. Miss Clark's textbook on Elementary Science had been published already. So the science editor had to examine her text carefully and also learn what schools in general were doing in the first year in high school science.

Very few schools in New England were offering anything resembling general science but it was rapidly gaining in popularity in other parts of the country. Whitman soon learned that General Science included material that had a real appeal to the pupils and he became thoroughly sold on the idea. In the summer of 1916 he gave a course in General Science at the summer session of the State Normal School at Hyannis, Massachusetts. During the summer Dr. Otis W. Caldwell, then of the University of Chicago, gave a lecture at

* Most of the information in this article is based on material furnished by Walter G. Whitman and should be credited to him.

Hyannis. In talking with Dr. Caldwell, Whitman suggested that general science was not making as much headway in New England as it was in some other parts of the country and asked if he thought a science magazine, devoted to general science, would help teachers and improve the science teaching. Dr. Caldwell was very enthusiastic about the idea and suggested there were plenty of people sufficiently interested who would be willing to back the magazine financially, if anyone would be responsible in starting it. On October 5, 1916, Mr. Higgins, of Danbury, Connecticut, Normal School, reported that he had the names of 27 science teachers for the Advisory Board of *General Science Quarterly* and that they would guarantee financial help if the journal did not pay its way the first year.

The first number of *General Science Quarterly* came out November 4, 1916 and for 13 years continued under that name. While Mr. Whitman was teaching at the University of Nanking, China, in 1925–26, the late Orra Ervin Underhill served as Editor. During these years General Science became so well established no more promotion work was needed and the magazine was renamed *Science Education*. It never failed to pay its way financially and it never made a profit. No one down to the present time, February, 1953, has ever received any compensation, not so much as a penny, for any work in connection with the publication of the magazine. All work has been gratis.

General Science Quarterly became *Science Education* with the May, 1929, number. With this number *Science Education* became the official publication of The National Association for Research in Science Teaching. During the summer of 1931 Whitman sold the magazine to a group composed of Charles J. Pieper, Earl R. Glenn, Florence G. Billig, Gerald S. Craig, Walter G. Whitman, Clarence M. Pruitt, and NARST. Pieper was selected as Editor, a position which he held with high honor through the October, 1943 number. An Editorial Committee, with W. G. Whitman again serving most capably as Editor, published *Science Education* beginning with the November, 1943, number. This arrangement continued through April, 1944. With the October, 1944, number and continuing through December, 1945, Dr. S. Ralph Powers served most ably as Editor of *Science Education*. Since February, 1946, Clarence M. Pruitt has carried on the work as Editor. He had previously served as Business Manager and Book Review Editor (except for one year as Business Manager) since October, 1931.

THE GROWTH AND ACTIVITIES OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING *

HANOR A. WEBB

George Peabody College for Teachers, Nashville, Tennessee

When the activities of an organization such as ours are discussed, our attitude toward the present should be that of faith, toward the future that of hope, and toward the past—possibly—that of charity. It is my assigned task, however, to tell this faithful and hopeful audience of members and friends something of how the National Association for Research in Science Teaching (hereafter NARST) was born, and through what struggles analogous to infancy and childhood it passed, attaining the youthful vigor of a Silver Anniversary. If some of my comments seem the reminiscences of an elder, I beg your charity.

* Address at the Silver Anniversary Meeting of the National Association for Research in Science Teaching, Chicago, February 14, 1952.

Two colleagues of the earliest days—Curtis, Watkins—join with me on this program, each with a specific task of information. A gratifying number of our charter members are also here. Yet I see chiefly a new group of professionals in science education. This is as it should be on a Silver Anniversary. I will enlarge on this thought later in my report.

The birth and growth of NARST is best recorded in the periodical which is now our official organ. I draw upon the columns of *General Science Quarterly,* and its successor *Science Education,* for facts; I color these with recollections.

The first issue of *General Science Quarterly* was that of November, 1916, almost thirty-six years ago. Walter G. Whitman of the State Normal School, Salem, Massachusetts, was the editor and publisher. I was one of his earliest subscribers. The opening article in this journal was by the philosopher John Dewey, urging more and better science in the elementary schools. Thirteen additional articles, several by well-known educational authors, filled an attractive issue. Whitman himself wrote on "Lightning."

During the summer of 1916 a General Science Teachers Association had been organized in New England. Membership fee, including *General Science Quarterly,* $1.50. Its president, Walter G. Whitman.

The second issue of this journal opened with an article by that eminent educator, William H. Kilpatrick; his subject, "Project Teaching." Other articles contained practical information. Whitman wrote on "Twilight."

In Number 3 of Volume I, Otis W. Caldwell wrote on "A New Point of View in Science Teaching." His outlook was ever new! Earl R. Glenn * contributed references on science teaching from other educational magazines.

The *General Science Quarterly* appeared on time throughout Volumes II, III, and IV. Its contents were of great variety, being largely articles of factual nature that should interest a science teacher and his class. Practical methods of teaching, and the use of teaching aids, were stressed. Without disparaging the value of this material, it was not what we would call "scholarly"; that is, these were not the reports of studies and experimentation in science education. Veterans in teaching, such as Harry Carpenter of Rochester, John F. Woodhull of Teachers College, William Vinal of Cleveland, Elliott R. Downing of Chicago, expressed their philosophies. Youngsters such as Morris Meister of the Speyer School in New York City described their methods. Whitman, writing on wartime topics such as nitrates, nitroglycerine, potash, TNT, submarines, was a liberal contributor to his own journal.

In Volume V, in 1920, George W. Hunter and Hanor A. Webb * wrote their first articles for *General Science Quarterly.* These were reports of studies; their type became more numerous as research in the field of science education seemed to develop in many institutions. The names most often noted in the succeeding Volumes are those of G. A. Bowden, Gerald S. Craig, Ira Davis,* Elliot R. Downing, J. O. Frank, Earl R. Glenn,* Morris Meister, Ellis J. Persing, S. Ralph Powers,* Clarence M. Pruitt,* O. E. Underhill, Ralph K. Watkins.* These, and of course others, felt the urge to sow good seed, having faith that there would be a harvest of value to science teaching throughout the nation.

Now came the time set by Destiny for a new organization to be born. On Monday, February 27, 1928, a group of sixteen persons met in the Colonial Club in Cambridge, Massachusetts, during a convention of the Department of Superintendence of the National Education Association. These persons had come in response to an invitation sent them by W. L. Eikenberry * of the State Teachers College, East Stroudsburg, Pennsylvania. He had been pleased by his success in organizing a group of science

* Indicates a member of NARST present at the Silver Anniversary Meeting.

teachers in Pennsylvania a few years earlier. This achievement giving him courage, he surveyed a larger field and sent some forty invitations to individuals, in many parts of the nation, who had published studies in science education, or who had written helpful articles.

It was fitting and proper that W. L. Eikenberry * should be nominated from the floor, and elected the first chief officer of this organization that now celebrates its Silver Anniversary. At this meeting S. Ralph Powers * was elected Secretary, to serve for more than a decade. Elliot R. Downing was the third member of the Executive Committee, and Harry A. Carpenter the fourth. Dues of $1.50 were set for membership, and collected from those present. The minutes do not state whether the doors were locked.

On the next day a second meeting was held. Numerous motions were made and passed. Francis D. Curtis * was elected the fifth member of the Executive Committee. He was needed—so the story goes—to break a tie vote on raising the dues to $2.00. The additional 50 cents was collected from each one present, the doors being locked.

Eikenberry * presented to the group data concerning the scholarly attainments of thirty-three persons who had accepted his invitation to allow their names to be presented for membership in the new research organization. For each, one or more present testified on the basis of acquaintance, personal or professional. For the sixteen in the room it may have been a mutual admiration society; all thirty-three, however, were considered worthy, and elected to charter membership contingent on acceptance, and remittance of dues.

An argument ensued that now causes a smile. On the previous day the decision had been made to consider anyone invited, approved, and elected to be a charter member. But today some sprite of malice entered into the discussion, and it was narrowly voted that only those present—the sixteen—should be charter members. This was in 1928. In 1930, however, a more generous spirit prevailed, it was voted that all who had responded favorably to the invitation, had been elected at the Cambridge meeting, and had paid their dues, should be considered Charter Members.

This was a fair decision. In my own case I had been eager and earnest to volunteer for the new labors. I could not be at the first meeting—the creeks were too high between Nashville and Boston. I was there in spirit, and so were others. All thirty-three of us joined in the causes to which this membership dedicated us. I value the star by my name, designating me a Charter Member of NARST, as one of my most cherished professional emblems.

The issue of Volume XIII, Number 4, May, 1929, was the first to bear the name *Science Education* at the masthead. In an editorial Prof. Whitman, after referring to his thirteen years of responsibility for the magazine, wrote: "The need for a journal to promote general science alone no longer exists. . . . It is important that there be at least one journal whose purpose is the promotion of science teaching in *all* our schools. Such a journal has been started; you are now reading its first number. Its name is *Science Education*."

He then announced the editorial management of the new journal: Charles J. Pieper of New York University, New York City; Earl R. Glenn * of the State Teachers College, Montclair, New Jersey; Walter G. Whitman of the State Normal School, Salem, Massachusetts. Thus NARST and *Science Education* were wedded into a bond of mutual service. There are lines in Longfellow's *Hiawatha* that describe the mutual dependence of a man and a woman in the relationship of highest value; the last phrase reads, "Useless each without the other." Can we visualize a vigorous, influential Association without its journal? Or a journal dedicated to a profession without a sponsoring Association?

I have the list of Charter Members,

copied from the minutes of the 1930 meeting, in my hand. Twenty-five years have passed since the meeting of 1928. Has Providence been kind to these, or cruel? How many of these have been spared for continued service? Has earth, or Heaven, needed them more?

[Mr. Webb then called the roll of the Charter Members. In response to each name, personal friends raised their hands. For each living Charter Member the present location and work was given.]

Destiny has demonstrated the worthiness of these men. Only eight have passed away. Only four seem to have retired. Thus some twenty-one have been spared to labor in the vineyard of our calling. It is rumored that retirement impends for several—yet as a group it has been clear that some high Wisdom retained them longer than might have been hoped for in those early years.

The second annual meeting of NARST was held February 25, 1929, in Cleveland; the attendance, 60. A feature was the reports on recent research of ten members. The Committee on Publications, after considering the costs of other plans, recommended that *Science Education* be purchased by the Association. The 1930 meeting was in Atlantic City, at which the Constitution Committee of N. Henry Black, Hanor A. Webb,* and E. E. Wildman reported. Their draft, with minor changes, was adopted. Elliot R. Downing was the new president, and—with others—Clarence M. Pruitt * was elected to membership.

Who were the writers of these early volumes of *Science Education?* Names outstanding as frequent contributors are Downing, Curtis,* Caldwell, Palmer,* Glenn,* Meister. Yet always new names appeared above the articles—writers who in due time merited invitation to membership in NARST by virtue of their contributions to science education. The magazine became ever more specialized—an avenue for the publication of studies. Articles such as "How Paper Is Made" no longer appeared. *Science Education* had no appeal as a "popular" magazine—this, of course, was as the membership desired it.

The magazine began to carry numerous reviews of recent books, and abstracts of studies published in other educational journals. The most interesting articles in the popular scientific magazines were digested, giving a helpful library list for student assignments. The space devoted to these notices, and the labor involved in preparing copy for their publication, certainly deserved the attention of science teachers. A worker may not mind the drudgery of compiling lists and writing reviews if he believes his service is used and appreciated. No one, however, is happy over "love's labor lost."

I do not believe these labors of Curtis,* Glenn,* Pruitt,* and others in their carefully prepared reviews and digests, were lost! I used their lists; I am sure that many others did as well. The increased number of library subscriptions to *Science Education* was also an indication of its valued service.

In 1933 *Science Education* took on a new page size, larger than before. Clarence M. Pruitt became Business Manager—and has not been unemployed even to this day, eighteen years later. There may be little money in the management of this magazine, but there must be a thrill in handling it!

The meeting in 1934 was at Cleveland, and Ralph K. Watkins * was president. In 1935 Atlantic City was the site, with Archer W. Hurd president. In 1936 Francis D. Curtis * served as president at St. Louis. In 1937 Walter G. Whitman was president at New Orleans. *Science Education* expanded to five issues per year, with advertisements to carry them.

In 1938 the number of issues per year was again raised, to seven. Digests of *unpublished* studies in science education were a new feature, prepared by Curtis.* No similar opportunity to keep up with progress in this field of teaching had been offered before, by any journal. It is a tribute to the activities of science educators that their

studies were numerous, and probably worthy. We like to feel that we are in a great company of truly earnest workers. A feeling of high comradeship develops under these circumstances. Our morale as science educators is lifted. We hope that the new generation receives the same thrills of association in an active team as was our own experience.

In 1938 Hanor A. Webb * was president at a double-barrelled meeting in Philadelphia and Atlantic City. After draping the shoulders of S. Ralph Powers * for ten years, the secretaryship fell as a mantle around the stalwart neck of Ellsworth S. Obourn.

I must move rapidly through the remaining years, although each of them presented problems, frustrations, achievements. There is something human in an Association like ours. Things are never as good as we hope, nor as bad as we fear. But the time was approaching when war, as it does to every aspect of civilized society, began to press upon us and disrupt our plans.

In 1939 the meeting was in Cleveland, with S. R. Powers * as president. In 1940, in St. Louis, Otis W. Caldwell was president. One may wonder why this dean of science teachers had not been honored much earlier. It was in deference to his modesty—his preference that younger men receive the recognition, and the responsibilities, for the sake of their own development. He accepted the presidency with protests—but if NARST was ever to show him this respect, it was time to do so. Dr. Caldwell's influence in NARST, as in other scientific organizations—even the great American Association for the Advancement of Science—was incalculable.

In 1941 at Atlantic City another veteran, Harry A. Carpenter, was honored by the presidency. In 1942 at Cleveland, G. P. Cahoon was president. That year, for the first time in twenty-six years of publication, *Science Education*—born *General Science Quarterly*—had serious difficulties in coming out on time, or at all. The magazine suspended publication in March and April; the October and November issues were combined; the December issue was delayed. Only five issues were planned for 1943; subscriptions for seven issues per year were adjusted.

Other changes may be noted in the slim volume of 1943. Two issues came out under the editorship of Pieper, who had taken the responsibility in 1929. The other issues were the work of a Publication Committee, with Whitman as chairman. The meeting of 1943 was at Cleveland, with Florence Billig as president.

In 1944 five full issues—each slim—were published. In October Powers *—faithful performer of any task that needed to be done—took over as editor. Miss Billig served a second term as president in Columbus. In 1945 there was an interesting shift to cheap paper for the journal. Its yellow contrast to the white pages at the beginning of the volume is a reminder that one must sometimes do the best he can with what he has. There was no meeting in 1945; Miss Billig continued her service as president of the Association.

In 1946 an "old" name appeared in a new capacity as Pruitt * became editor of *Science Education*. He continued as business manager. In fact, he became the owner of the magazine, and continues its publication to this day. Again we assume that the pride of ownership outweighs the profits.

Better days began to dawn for the Association in 1947. The magazine again used white paper. In a meeting at Atlantic City, Earl R. Glenn *—another veteran who richly deserved the honor and was competent to endure the headaches—served as president. Pruitt * became Secretary-Treasurer of the organization, and continues this service to the present.

In 1948 Ira Davis,* a veteran, was president—again at Atlantic City. But a feeling against Atlantic City as a sort of "permanent" meeting place was developing. The American Association of School Adminis-

trators, in the fringes of whose convention NARST had consistently met, was becoming too large for any city—save two or three—to serve as host. One recollection of many members at this meeting was the rather skimpy dinner, served in one of the Atlantic City hotels, at the price of $6.50. At this meeting a new constitution for NARST was adopted, with helpful changes.

Featuring one of the issues of *Science Education* for 1948 was a 67-page syllabus on a Freshman course in science, in the spirit of general education. This was prepared by N. Eldred Bingham * of Northwestern University. It is interesting to note that the South has kidnapped Bingham, and he serves at the University of Florida in Gainesville.

In 1949 Joe Young West, distinctly of the younger generation, was president at New York City. In 1950 another youngster in age but of adequate experience—N. E. Bingham *—presided at Atlantic City. A number of research committees were appointed, indicating a revival of earnest study in the field of science teaching. In 1951, again at Atlantic City with Betty Lockwood * presiding, these committees made progress reports.

A new trend may be indicated by the appointment of active committees for the productive work of NARST. I observe—as you do—that these committees are scheduled for two busy sessions at this Silver Anniversary meeting. Although the value of individual effort in research can not be discounted, it may be that the "lone wolf" may not work most effectively. I once heard President Herbert Hoover express this idea in an address; said he:

"The days of the inventor in a garret are gone, if indeed they ever existed. Today's inventions are primarily the outcome of work by teams, each individual contributing to the plans according to his special knowledge and experience. In industry these teams are provided with facilities for experimentation at a cost that would appall the single worker. The results of coordinated research have been good."

Possibly science education has come upon days when coordinated research, on a nation-wide base, will be most productive.

After research, then comes the problem of publication. It is doubtful whether an editor can now print long, detailed, and highly statistical reports. There are two reasons. First, the cost of composition per page is very high, hence he must utilize his space as effectively as possilbe. Second, modern readers will not wade through a morass of figures; there are too many interesting articles to read. A somewhat new talent, therefore, must be developed by the modern researchers in science education—a talent possessed in its highest form by only a few of the older generation of reporters of research. This talent must be an ability to set forth, after the meticulous techniques of educational investigation have been applied, the truly essential discoveries in concise, interesting, and stimulating articles.

Frankly, the hundreds of digests prepared by Curtis * from published and unpublished studies are as instructive as the articles themselves, and much easier to read and understand. With the technique of a master, Curtis * dug the jewel from its matrix, and gave it a polish in his paragraph that even the original author could appreciate. Undoubtedly the new committees will see the need for announcing only the essences of their findings. As someone has remarked: "It is of little significance to count the hairs on a dog's tail, but of much import to discover the meaning of how the dog holds his tail."

Well, here we are at the Silver Anniversary Meeting of NARST! The youngest Charter Member is now mature; the maturer Charter Members are now elderly. But while men and women inevitably become enfeebled as the years pass—to which the philosophical are reconciled—an organization such as ours should grow stronger as it grows older.

There is a spirit in the minds of the present active Charter Members best indi-

cated by the famous phrase—"to you we throw the torch!" Twenty-five years ago some thirty-three of us put our best thought into this Association. To our minds, I believe, we added our souls—this thing *must* succeed—it had an element of sacredness!

You who are assuming responsibility for NARST have the minds, we know, to carry the Association forward to its Golden Jubilee. We believe you also have the souls to sense its sacredness to our profession, and to the students at all levels whom we teach. Lord Tennyson expressed it nobly, thus:

"Let knowledge grow from more to more,
But more of reverence in us dwell,
That mind and soul, according well
May make one music as before—
But vaster!"

This is what *we* believe *you* will do!

Editor's note: In characteristic Hanorian style, Professor Webb has graciously and modestly underemphasized the important part he played and the influence he exerted in the formative years of NARST. On more than one occasion acco.ding to eye-witness accounts when the debate waxed warm and furiously, his voice soothed the Angry Spirits and the Dove of Peace settled down upon the assembly and it spake as one Voice—and a major crisis had been averted once more.

THE BEGINNINGS, EARLY MEMBERSHIP, AND EARLY ACTIVITIES OF NARST *

RALPH K. WATKINS

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THE title for this part of the program was suggested by the executive committee rather than chosen by the speaker. It is pleasant to be so remembered in spite of the fact that the title smacks a little too much of an old man's reminiscences to be wholly comfortable.

The NARST was organized at the Boston meeting of 1928 with W. L. Eikenberry as the first president. The date has considerable significance in relationship to the nature of the organization and its further destiny.

The organization was formed as the enrollments of the public high schools began to push towards the amazing peak reached in the '40s. The Commission on the Reorganization of Secondary Education had made its pronouncements on the "Cardinal Principals of Secondary Education" in 1918. The bulletin on the Reorganization of Science in Secondary Education had been published by the U. S. Bureau of Education and had reached the science teachers of the country in 1920. This bulletin had been prepared by a committee under the chairmanship of Otis W. Caldwell, one of the charter members of the NARST. This bulletin contained recommendations for junior high school science, general science, and general biology, along with certain growing ideas concerning functional physics and functional chemistry. World War I was over, the impact of the financial depression had not become acute, and World War II seemed remote.

By 1928 nature study in the elementary schools was beginning to mature into elementary science. The era of the Comstocks working under the stimulation of Liberty Hyde Bailey at Cornell had begun to pass. E. Laurence Palmer, another of our charter members, had begun his work at Cornell. Gerald Craig was working at the Horace Mann School at Teachers College, and Morris Meister had begun his early experiments with science for children.

Behind all this there were coming about significant changes in the basic philosophy of education. John Dewey has had his influence on science teaching, too. The present student of science teaching will not have

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to search too diligently to find articles dealing directly with science instruction written by Dewey.

By the time of the beginnings of the NARST we began to have a science of psychology and its applications in the field of educational psychology were becoming scientific, too.

Educational measurement had come into existence and its tools were beginning to evolve out of the early stages of crudity. With a science of educational psychology, the tools of educational measurement, and educational statistics there was underway a great surge toward experimentation in education. The results of education were to be experimentally evaluated and measured objectively. All education was to become scientific.

Against this background of educational trends, it is desirable to consider some of the personalities who contributed to the original membership of the NARST.

W. L. Eikenberry and O. W. Caldwell had been at the University of Chicago, Caldwell had gone to Teachers College of Columbia University to head the newly organized Lincoln School. Caldwell had been active in the AAAS. Eikenberry was most active in the attempt to get a national organization of leaders in science education. These two were co-authors of the first widely distributed textbook in general science, *The Elements of General Science*.

At the University of Chicago was E. R. Downing. Downing contributed much to both the organization of an elementary science for children and to the teaching of high school biology. Downing had written two books that went into the hands of great numbers of elementary school teachers, *A Handbook of Biological Nature Study* and *A Handbook of Physical Nature Study*. These two books were later revised and reissued under more modern titles. They had great influence upon numbers of science teachers in the midwest.

Also early at the University of Chicago were Charles J. Pieper and W. L. Beauchamp. These two taught in the University High School. They produced another pioneer textbook in general science, *Everyday Problems in Science*. This book was developed about the large unit concept of Henry C. Morrison of the University of Chicago and its teaching techniques illustrated the application of the Morrisonian theories.

S. R. Powers who had been teaching in a high school in Illinois had gone to the University of Minnesota for graduate study. He had built an objective test for chemistry and attempted to prove that pupils having high school chemistry made better progress in beginning college chemistry than did pupils having no high school chemistry. Upon completion of his graduate program Powers was chosen to succeed J. F. Woodhull at Teachers College of Columbia.

Early graduate students from the original NARST group at Teachers College were Gerald Craig, Harry Cunningham, Francis Curtis, Earl Glenn, and Morris Meister. It is interesting to note that these men cover a geographic distribution from Meister at home in New York City to Curtis who came from the Pacific Coast.

Craig was interested in developing elementary science for teachers, Cunningham in the education of teachers for elementary science, and Meister in physical science for children. Glenn and Caldwell became interested in improved school furniture for science experimentation and demonstration. They developed the Lincoln School science furniture.

We have mentioned the beginning work of E. Laurence Palmer with elementary science at Cornell. Palmer's work with the Cornell leaflets and bulletins should find its place here, too.

At the time of the organization of the NARST Joseph Lunt was at work in Boston. Lunt was a pioneer in the development of science equipment for elementary and general science.

By this time Hanor Webb had begun his career in the education of science teachers

at George Peabody College for Teachers, Nashville, Tennessee. Webb had carried out an extensive study which attempted to synthesize the early thinking concerning the objectives of general science. Later he was to develop one of the most stimulating experiments in the measurement of scientific problem solving that we have had.

Walter G. Whitman was at the teachers college in Salem, Massachusetts. He had built, operated, and managed the *General Science Quarterly*. It was out of this pioneer periodical that the *Science Education* of today grew.

J. O. Frank was at the teachers college in Oshkosh, Wisconsin. Frank had written almost the only existing textbook of his day on the teaching of chemistry. He had gathered also data on superstitions of people of the Fox River Valley of Wisconsin. It was his idea that science education could counteract these superstitions. Later Caldwell and Lundeen were to attack a similar problem on a more ambitious scale.

Most of the charter members of NARST presented so far have been associated somehow with colleges and Universities. There were in the early organization a group of men who represented leadership in science education in the field. These were the relatively few science supervisors of the larger cities. Of these we remember most distinctly Harry Carpenter of Rochester, New York, John Hollinger of Pittsburg, W. F. Roecker of Milwaukee, G. L. Thiele of Detroit, W. R. Teeters of St. Louis, and Edward E. Wildman of Philadelphia.

As we have gone through this roster of names anyone who has followed the history of science teaching for the past twenty-five years will recognize the authors of a large percentage of the school science textbooks of the period. A few of these books we have mentioned. No attempt can be made to present a full list.

Some of the early members of NARST who will be recognized for their contributions to textbooks are: Caldwell and Eikenberry, Pieper and Beauchamp, Francis Curtis, Joseph Lunt, Morris Meister, E. Laurence Palmer, S. R. Powers, Ralph Watkins, Hanor Webb, Walter G. Whitman, George Wood, Gerald Craig, Ellsworth Obourn, Ira Davis, Benjamin Gruenberg, and George Hunter.

Of these perhaps special mention should be made of the early textbook writing of George W. Hunter. Hunter did much to set the pattern for modern science textbooks. One of his early books published under the title of *Civic Biology* emphasized at least two features now found in most school science textbooks. First the text itself was organized about problems which were assumed to be the problems of the youthful readers rather than being organized about a purely logical sequence of science topics. Secondly, the pedagogical devices, teaching aids, and learning activities were incorporated as integral parts of the whole. Hunter used his illustrations and diagrams, too, as a part of his teaching and learning machinery.

A notable feature of NARST is illustrated by the professional relationships of its numerous textbook writers. The men and women concerned were in most cases firm professional and personal friends. Programs have always been at a high professional level. Members have looked forward to friendly meetings around a luncheon or dinner table. The vested interests of individuals in particular textbook ventures have seemed not to color these fine relationships.

Probably the most significant feature of the NARST has been in its emphasis upon educational experimentation. This was in evidence from the establishment of the organization. It will be remembered that there had been an attempt to form an overall organization of all those interested in science teaching, perhaps comparable to the national councils of teachers in English, mathematics, and social studies. Instead, however, the NARST developed as a relatively small closely knit group of those who

were attempting to carry out, or direct, research in science teaching.

We can mention here only a few of those from the list of charter members whose research may be considered as pioneer investigation and as opening the way for investigators to follow.

Hanor Webb at Peabody attempted to untangle the threads of confused purpose in the development of general science. He developed a synthesis of objectives in general science from the opinions of "leaders" in the field and from an analysis of published materials. Later Webb attempted to measure laboratory problem solving by means of manipulative tests with problem situations involving concrete equipment.

E. R. Downing directed the early attempts of a group of graduate students to prove experimentally the relative merits of lecture-demonstration teaching as compared with laboratory experiences. These experimenters used control group techniques and objective measurement. The results of a series of these experiments were published in Downing's book on the teaching of science. Since then numerous similar experiments have been carried out and there is a voluminous literature on this one issue alone in science teaching.

As we have mentioned previously, Pieper and Beauchamp were experimenting with large unit organization and with the Morrisonian concept of sequence in learning within the unit. They did make use of objective measurement of results. They did not always attempt to prove through the use of control groups the merits of their approach as compared with other science teaching. Instead they chose to illustrate what they had been doing by means of text material developed for the purpose.

S. R. Powers attacked the problem of developing the tools for objective measurement in the field of elementary chemistry. Thirty years ago, college chemistry departments placed all beginning college chemistry students in the same sections without any regard to whether they had had high school chemistry or not. Typically the college chemistry instructor said that he would prefer that his students come to college without having had chemistry in high school. Powers, with his objective tests in chemistry, sought to find out whether or not this bias against high school chemistry was tenable.

Besides these early investigations in science teaching we have had some pieces of pioneer research that have served the function of proving that science learning does take place when freed from the rigid restrictions of logical relationships within the structure of the sciences themselves. Morris Meister working with children of the upper grades demonstrated that these children did learn some science in the processes of manipulation of commercial science kits and play apparatus.

Francis Curtis demonstrated a considerable learning of science through extensive reading in a comparatively wide range of well selected books and magazines in natural science. As a matter of fact, Curtis set off a kind of chain reaction which led investigators in other subjects, notably literature and American History, to attempt to establish learning values in extensive reading.

Possibly the work of your speaker in attempting to establish the learning values of science projects could be placed in this latter category of investigation.

In the field of investigation of the values of comparative methods of science teaching the work of Archer W. Hurd should be mentioned. Hurd, working with pupils in high school physics in St. Paul, attempted to determine the comparative merits of problem organization as compared with topical organization. In this case experimentation seemed to contradict educational theory, for the topical organization seemed superior.

We cannot close this brief description of the research endeavors of early members of the NARST without mentioning the work of Francis Curtis in gathering and

abstracting the significant research in science teaching down to 1939. These compilations of Curtis have been published in three volumes, *A Digest of Investigations in the Teaching of Science 1926, A Second Digest of Investigations in the Teaching of Science 1931,* and *A Third Digest of Investigations in the Teaching of Science 1939.* These volumes have been of inestimable value to all interested workers in the field. Since the publication of the third volume of Curtis' later summarization is to be found in the 46th Yearbook, Part I of the National Society for the Study of Education, *Science Education in American Schools,* and in various "Reviews" of the American Educational Research Association. The digesting in the latter sources is also primarily the work of members of the NARST.

Within the twenty-five year period of the NARST there have been published two ambitious volumes that have attempted to outline programs and trends in American science education. These volumes are the Thirty-first and Forty-sixth Yearbooks, Parts I of the National Society for the Study of Education, *A Program for Teaching Science,* and *Science Education in American Schools,* published in 1932 and 1947. All of the members of the committee responsible for the 31st Yearbook were members of NARST. All were charter members. Other contributors to this volume were also members of NARST. Five of the six members of the committee responsible for the preparation of the 46th Yearbook were members of the NARST, four of them charter members. Other members of the organization were contributors.

The dissemination of the findings of research concerning science teaching has always been of great concern to the NARST as an organization. As a small association with only moderate dues, the financing of a magazine or a series of yearbooks of national scope has always been a problem.

At the time of the founding of the organization, W. G. Whitman, one of the charter members, owned and managed the *General Science Quarterly.* Various reports of research by those later to become members of the NARST had appeared in this magazine. Professor Whitman proposed that the *General Science Quarterly* become the official magazine of NARST. The association formed an editorial, or publications, committee, but the ownership and management remained in Whitman's hands.

Later a small group of members of the NARST, as a sincere professional service, purchased the *General Science Quarterly* from Mr. Whitman. The title was changed to *Science Education* and Charles J. Pieper became the editor. From these beginnings has grown the magazine as we now know it with its present management and editorship in the hands of Clarence M. Pruitt. The NARST has never owned the magazine and so is deeply indebted both to those members who have aided in its financing and to those who have given large amounts of time and energy to its editing.

This report of early endeavors of NARST has been presented in the hope that the present generation of workers in science education may receive some stimulation in the accomplishment of those things not achieved by the elders. It is not intended to leave the impression that "there were giants in those days." Rather we would like to suggest that the younger people concerned with science teaching have better tools for investigation, some nucleus of findings from earlier investigators, a whole new body of science not in existence twenty-five years ago, and much better means of communication. They should now be able to uncover that which the older generation could see but dimly. The NARST may serve to furnish the machinery for teamwork so necessary for research in our day.

CHARTER MEMBERS OF NARST *

CLARENCE E. BAER

Mr. Clarence E. Baer is an electronic scientist in the Radar Laboratory, U. S. Air Forces, Wright-Patterson Air Force Base, Dayton, Ohio. Although Mr. Baer is not now engaged in teaching he has an interesting background in science education. He was at one time a high school science teacher in Seattle, Washington and New Castle, Pennsylvania. Later he was New York State Supervisor of Science, then science editor of Eastman Teaching Films, and finally Head of Science Department, State Teachers College, Oswego, New York. In these positions he has contributed to the education of many science teachers, especially as science supervisor and editor of Eastman Films. His principal publications have been articles in educational journals and a teachers guide to the use of motion picture visual aids.

He has an A.B. degree from Cornell University and a Master's degree from Teachers College, Columbia University.

He has been a member of several state and national associations concerned with science education. He was a charter member of NARST and has maintained his membership in the Association since 1928.

DR. FRANCIS D. CURTIS

Dr. Francis D. Curtis is Professor of Education and of the Teaching of Science at the University of Michigan. Dr. Curtis has been at the University for 28 years where he has worked in the teaching of science and secondary education. He has taught practically all high school courses (to quote him, "some you can name and some you'd be ashamed to name") having done pioneer teaching in general science, household physics, and physical science.

He has a B.S. and M.A. degree from the University of Oregon, and a Ph.D. degree from Columbia University.

He has contributed to the education of thousands of science teachers through his courses. Since he has been at the University he has directed 400 masters theses and 20 doctoral studies.

Dr. Curtis has been a member of, and held office in, a number of the national and regional associations concerned with science education. He is a charter member of NARST and has actively served the Association as a member of the executive committee, vice-president, and president.

He has been chairman of the Committee of the U. S. Federal Security Agency on Research in Teaching of Science, worked on the North Central Association *Study of the Teaching of Science in the Secondary Schools,* and served on the NSSE committees for preparation of the parts of 31st and 46th Yearbooks pertaining to science education.

Dr. Curtis has published more than 200 articles on education and nearly 40 books and bulletins, including textbooks in general science and biology. All research workers in science teaching bless him for his three volumes of *Digests of Investigations in the Teaching of Science* and will be happy to learn that he is at work on later volumes. Among his publication plans for the future is a methodology on the teaching of science.

Dr. Curtis is listed in Who's Who, American Men of Science, World Biography, Fellow in American Association for the Advancement of Science, Phi Delta Kappa, and Biographical Encyclopedia the World.

PROFESSOR IRA C. DAVIS

Professor Ira C. Davis is Professor of Science Education, and Chairman of the

* The following citations were read by President Betty Lockwood Wheeler as she presented each member with a Charter Member Recognition Certificate at the Silver Anniversary Dinner meeting, Florentine Room, Congress Hotel, Chicago, Illinois, February 15, 1952. The citations for Charter members not present were prepared by Clarence M. Pruitt.

Department of Education, University of Wisconsin. He has been at the University since 1917, although prior to that Professor Davis had been a science teacher in the public schools in Washington and Wisconsin for seven years.

He has an A.B. degree from Ripon College and an M.A. degree from the University of Wisconsin.

In his teaching at the University he has contributed to the education of well over a thousand science teachers. He has directed the research of 60 students for the master's and doctor's degrees.

Professor Davis has served as president of the science section of NEA, chairman of the National Committee on Science Teaching, and President of the Central Association of Science and Mathematics Teachers.

He was one of those who supported the movement to organize NARST in 1928. He has served the Association as president, vice-president and a member of the executive committee.

He has written over 30 articles on education and has published five science textbooks and workbooks.

As far as the immediate future is concerned, Professor Davis plans to continue with his work at the University.

W. L. EIKENBERRY

Dr. W. L. Eikenberry is retired from active service in science education although he still maintains an active interest in NARST as evidenced by the promptness with which he replies to correspondence pertaining to Association activities and his presence with us this evening.

Dr. Eikenberry has a B.S. degree from the University of Michigan and a D.Sc. degree from Mt. Morris College.

He has taught science at Mt. Morris College and in the University of Chicago High School. He taught botany in the St. Louis Schools and was in charge of the training of biology teachers at the University of Kansas. He was Head of the Science Departments at East Stroudsburg Teachers College in Pennsylvania and later held the same position at Trenton, New Jersey State Teachers College. In these positions he has been responsible for the education of many science teachers.

Dr. Eikenberry has published a number of science textbooks. In fact some of us "cut our pedagogical teeth" on one of his early general science texts. He has also written numerous articles on science education.

Although he has been a member of various national professional organizations, we pay honor to him this evening as the first president of NARST. As you will recall it was his letter to some 35 educators that brought together the first group out of which NARST was born.

EARL R. GLENN

Mr. Earl R. Glenn is Professor of Physics and Head of the Department of Science at the New Jersey State Teachers College at Montclair, New Jersey. He has taught at the Harrison Technical High School, Chicago and at the Lincoln School of Teachers College and Teachers College, Columbia University. He has an A.B. degree from Indiana University and an M.A. degree from Teachers College.

During the past thirty years Professor Glenn has guided the work of more than 500 undergraduate students and more than 750 graduate students in science. He is the author of about 40 articles, 3 textbooks in general science, standardized tests in chemistry, general science, and physics, and half a dozen or so bulletins.

He has been an active member of NARST since its beginning and served on the Executive Committee and as Vice-President and President. He is a Fellow in the American Association for the Advancement of Science and has been active in a number of science teachers associations.

During the next two years he will be a

Fulbright Professor working under the U. S. State Department and the Public School System of the Philippines.

DR. E. LAURENCE PALMER

Dr. E. Laurence Palmer is Professor in Nature, Science Education, and Conservation at Cornell University. He is Director of Nature Education for the Nature Magazine and Director of Conservation Education for the National Wildlife Federation. He holds A.B., M.S., and Ph.D. degrees from Cornell University.

Early in his professional career, Dr. Palmer was a Professor of botany at Cornell and Iowa State Teachers College. He became a Professor of Rural Education at Cornell in 1919, where he has served thousands of science teachers in his classes and many times that number of teachers through the Cornell Leaflets. Thirty thousand of these leaflets have been distributed to teachers each year during the past 30 years. In addition to his teaching and writing he has directed about 50 doctoral and 75 masters theses.

He has been an active member and held office in numerous national organizations concerned with science education. He has been a member of NARST since 1929 and actively supported its work. He has served on two national surveys of Nature Study published as Nature almanacs; the New York State Committee on Elementary Science and Conservation; and a number of national surveys on Conservation Education.

He has published over 500 articles including a Fieldbook on Natural History.

Dr. Palmer expects to retire from Cornell in the summer of 1952 and will devote his time to acting as director of Nature Education for Nature Magazine and Director of Conservation Education for the National Wildlife Federation. In these positions he will continue to serve education as he has for the past 40 years.

DR. S. RALPH POWERS

Dr. S. Ralph Powers, Professor of Natural Science, is head of the Department of Teaching of Natural Sciences at Teachers College, Columbia University. He began teaching in the rural schools, of Menard County, Illinois. Later he taught high school chemistry in Indiana, was an instructor of science, University of Minnesota High School, and instructor in education at the University of Minnesota. He went to Teachers College in 1923 and has been head of the Department of Teaching of Natural Sciences since 1928. In the 29 years that Professor Powers has been at Teachers College he has directed the graduate educational programs for several thousands of teachers. He has directed doctoral research studies for more than 60 students. Dr. Powers has an A.B. degree from the University of Illinois and M.S. and Ph.D. degrees from the University of Minnesota.

His influence on science education has extended well beyond his immediate work at Teachers College. He has been an active member of both national and regional associations in education. He has either directed or otherwise been associated with a number of national studies related to science education. Notable among these are: Chairman of the Committee on Teaching of Science of the NSSE 31st Yearbook; Chairman of the Committee on Research in the Teaching of Science and Mathematics, 1942, 1945, 1948, for the American Educational Research Association; and Administrative Officer of the Bureau of Education Research in Science, 1934–42.

He has published approximately 60 articles on education, five textbooks in science, and other professional books in the teaching of science. He served briefly as Editor of *Science Education*.

Dr. Powers was the recipient of the Outstanding Achievement Award on the occasion of the Centennial of the University of

Minnesota College of Education, May 24, 1951.

He served NARST as its secretary from the beginning in 1928 to 1937 and was president of the Association in 1938.

Dr. Powers plans to retire from his work at Teachers College this year after 29 years of service.

F. ATHERTON RIEDEL

Dr. F. Atherton Riedel is Professor in the Physical Science Department at Oklahoma A and M College. His teaching experience includes Greeley, Colorado; Biology and Critic Teacher at University of Kansas; Kansas State Teachers College at Pittsburg; University of Puerto Rico; Wilson Teachers, Washington, D. C.; and Morehead Teachers College, Kentucky. He holds an A.B. degree from Miami University (Ohio), an M.A. Teachers College, Columbia, and a Ph.D. degree University of Colorado.

He is the author of a number of articles relating to science teaching. He served as a civilian instructor in the Chemical War Department in England, France, and Germany in 1945. He is now interested in developing a course in the history and methods of science as a human endeavor.

DR. C. L. THIELE

Dr. C. L. Thiele is Divisional Director of Exact Sciences, Detroit Public Schools. He has served as a teacher and principal in public elementary and secondary schools in California and Indiana. He has taught summers and on a part-time basis over a period of ten years at Wayne University, University of Minnesota and San Jose State College in California. As a college teacher and a public school supervisor of science he has contributed to the professional education of several thousand science teachers.

Dr. Thiele has A.B. and M.A. degrees from the University of California and a Ph.D. degree from Columbia University.

Dr. Thiele has been a member of several national organizations concerned with science and mathematics education. He has been president of the National Council on Elementary Science. He has been an active member of NARST since 1929. He has served the association as a member of the executive committee and as its president.

He has served on several state and national studies including the New York Regents Inquiry and the North Central Association's *Fundamental Skills Committee.* His further contributions to education include the publication of numerous articles and some 25 books and pamphlets.

At present he is in the process of developing a high school course which might be called "Occupational Science", which will feature science skills used in industry by workers who have neither college nor technical school training in science.

RALPH K. WATKINS

Dr. Ralph K. Watkins is a Professor of Education at the University of Missouri. His early experience as a teacher was obtained in public elementary schools and high schools in Shelby County, Missouri. He taught in the University of Missouri Elementary School and later became teacher and supervisor of science in the University High School. During his 35 years as a teacher at the University he has helped educate a large number of science teachers as well as other teachers who have been in his classes. During this period of professional service he has directed several hundred masters theses and 25 doctoral studies. He holds B.S., M.A., and Ph.D. degrees from the University of Missouri.

He has been a member of a number of national associations concerned with the improvement and advancement of education. He has been an active member of NARST since 1929 and has served both as a member of the executive committee and president of the Association.

Dr. Watkins served as a member of the NSSE Committee for the 31st Yearbook

and as an associated contributor to the 46th yearbook. He has published textbooks in general science, has contributed chapters to professional books and written numerous curriculum bulletins.

At present his work involves graduate courses and the direction of graduate work. He is primarily concerned with general problems of curriculum and teaching rather than science education.

DR. HANOR A. WEBB

Dr. Hanor A. Webb is a Professor of Chemistry and Science Education at George Peabody College for Teachers. He began his teaching career in public high schools. Later he was Head of the Departments of Biology and Chemistry at West Tennessee State College at Memphis and went to George Peabody College for Teachers in 1917. In his 40 years as a college teacher he has helped educate several thousand science teachers. He has directed the research studies of over a hundred masters students and some 30 doctoral candidates.

He has an A.B. degree from the University of Nashville, M.S. degree from the University of Chicago, and a Ph.D degree from George Peabody College for Teachers.

Dr. Webb has been an active member of a number of national and local educational organizations and has held office or chaired important committees in those organizations. Since 1929 he has been an active member of NARST. He has served the association as a member of the executive committee and was its president in 1937.

Since 1914 he has been active in writing and editorial work. Beginning with 1914 he has published several articles on education each year. He has written two books in general science and has contributed science materials to children's encyclopedias. He was editor of *Current Science* for 20 years and served as chairman of Magazine Advisory Board of NSTA.

He reports that he plans to retire in 1953. Although his plans are indefinite he would like to do more outdoor work and less office and editorial work, "in an effort to remain on this interesting old planet as long as possible."

WILBUR L. BEAUCHAMP

Mr. Wilbur L. Beauchamp is Professor of the Teaching of Science at the University of Chicago where he has been for many years. Other teaching experience includes Manhattan and Wichita, Kansas.

Professor Beauchamp is co-author of a number of textbooks in elementary science, junior high school science, and senior high school science—(with Pieper), *Everyday Problems in General Science* and *Everyday Problems in Biology;* (with Blough and Melrose) *Discovering Our World, Books I, II and III, All Around Us, How Do We Know,* and (with Mayfield and West)—*Science Problems Books I, II, and III.* Professor Beauchamp has always been interested in problems of how to teach science more effectively.

GERALD S. CRAIG

Dr. Gerald S. Craig is Professor of Education, Teachers College, Columbia University. Dr. Craig has been associated with Teachers College since 1925. Other teaching experience includes Ballinger, Texas, High School; Baylor University; State Normal School at Bloomsburg, Pennsylvania; White Plains, New York; and Puerto Rico. He has a B.S. degree from Baylor University and M.A. and Ph.D. degrees from Teachers College, Columbia University.

Dr. Craig has greatly affected the teaching of elementary science in this country through his elementary science course of study, his popular and widely used elementary science textbooks and other publications, through articles, and numerous talks and conferences. He made important contributions to the Thirty-first and Forty-sixth year books of the National Society for the Study of Education. Dr. Craig may most appropriately be called the leader in elementary science education in this country

and the one person most responsible for its important place in the elementary education program of today.

Dr. Craig is a former President of NARST and a former President of the National Council for Elementary Science.

HARRY A. CUNNINGHAM

Dr. Harry A. Cunningham is Professor of Biology and Head of the Department of Biology, Kent State University, Kent, Ohio. His teaching experience includes elementary and secondary schools, University of Kansas, and University of Chicago. He has a B.S. degree from Muskingum College, New Concord, Ohio; M.A. degree University of Chicago; Ph.D. degree, Columbia University.

He has directed the science education of more than 2,000 students. He is the author of some 28 articles relating to science teaching and 4 books and pamphlets. Many members will recall his excellent article in *Science Education* (March 1946), summarizing the research in lecture demonstration—individual laboratory work in science-teaching.

He has served as Secretary, Vice-president, and President of both the National Council on Elementary Science and American Science Teachers Association. He is a Fellow in the American Association for the Advancement of Science.

DR. ARCHER W. HURD

Dr. Archer W. Hurd is Director of the Bureau of Educational Research and Service, Medical College of Virginia. Dr. Hurd began his career in teaching as a seventh and eighth grade teacher in Wisconsin. Since then, he has taught high school science, served as a research associate, director of a bureau of educational research, a professor of education and dean of the college at Hamline University. He has been in his present position at the Medical College of Virginia since 1943. In his work as a teacher he has contributed to the education of hundreds of teachers.

Dr. Hurd holds Ph.B., M.S., and Ph.D. degrees.

In addition to his teaching Dr. Hurd has influenced education through his active membership in a number of national and local professional associations. He has been an active member of NARST since 1929, and served the Association as president, vice-president and chairman of various committees.

Since 1925 he has published about 100 articles and 14 books most of which are reports of research that he has conducted or directed. Included in his publications are four textbooks.

In response to the question: What are your plans for the future? he replied, "Keep Going."

FRANK C. JEAN

Dr. Frank C. Jean is Professor Emeritus of Biological Science, Colorado State College of Education, Greeley, Colorado. His teaching experience includes Nebraska Public Schools, Nebraska State Teachers College at Peru, and Chairman of Science Division at Colorado State College of Education. He has A.B., M.A., and Ph.D. degrees from the University of Nebraska, and an honorary D.Sc. degree from Colorado State College of Education.

He has guided the science education of an estimated 5,000 students, 50 for masters degrees and 10 for the doctorate degree. He is the author of a number of articles and co-author of two well known textbooks in biological and physical science survey.

During his retirement Dr. Jean plans to keep the two survey books up-to-date and write a book on the social implications of science.

MORRIS MEISTER

Dr. Morris Meister is Principal of the Bronx, New York, High School of Science. His other teaching experience includes

Speyer and Horace Mann Schools of Teachers College, Columbia University, New York Training School for Teachers; Haaren, New York, High School; and the City College of New York. He has a B.S. degree from the City College of New York and M.A. and Ph.D. degrees from Teachers College, Columbia University.

He is the author of numerous articles in science education and is author and co-author of a well-known series of textbooks in elementary science and junior high school science. For many years he was editor of *The Science Classroom.* He was also science editor of "Richards Cyclopedia." He has served as director, Vice-president, and President of the National Science Teachers Association. He is a Fellow in the American Association for the Advancement of Science.

ELLSWORTH S. OBOURN

Dr. Ellsworth S. Obourn is Head of the science department of the John Burroughs School in Clayton, Missouri, a position he has held since 1923. Other teaching experience includes high schools at Elmira Heights, New York and Mansfield, Pennsylvania; State Teachers College at Mansfield, Pennsylvania; State Teachers College at Shippensburg, Pennsylvania; Teachers College, Columbia University; New York University; and Duke University. He has a B.S. degree from Columbia University and a Ph.D. degree from New York University.

He is the author of numerous articles in science education and textbooks in general science and biology. He served as Secretary-Treasurer of NARST for ten years, 1938–1947.

ELLIS C. PERSING

Mr. Ellis C. Persing is lecturer in Science Education at Western Reserve University and teacher of science in West Technical High School, Cleveland, Ohio. Other teaching experience includes five years in rural schools in Pennsylvania; six years teaching biology, physics, chemistry, and general science in high schools in Pennsylvania, New York and North Dakota; five years as head of science department of Glenville High School in Cleveland; fifteen years as assistant professor of elementary science and biology in School of Education, Western Reserve University; and since 1936 in present position.

Mr. Persing has an A.B. degree from Bucknell University and an M.S. degree from the University of Chicago. He is a member of a number of science organizations and served as President of the National Council of Elementary Science (1931–32) and as President of the American Nature Study Society (1933 and 1934).

Many readers will recall his numerous articles (27) in *Normal Instructor and Primary Plans* and twenty-one articles in such magazines as *School Science and Mathematics, General Science Quarterly, Leica, Science Education,* and so on. He served as Editor of *The Book of Knowledge Lesson Series* (The Grolier Society); Editor *Science and Invention School Service,* Editor of *The Classroom Guide* (The Grolier Society); and co-author (with K. M. Persing) *General Science Workbook* and co-author of Elementary Science Series (with Peeples) Books One, Two and Three; (with Wildman) Book Four; (with Thiele) Book Five and (with Hollinger) Book Six.

Mr. Persing's present interests include photography, conservation, and evaluation.

CHARLES J. PIEPER

Professor Charles J. Pieper is Professor of Education and Chairman of the Department of Science Education, School of Education, New York University. His other teaching experiences includes Shortridge High School, Indianapolis, Indiana; University of Minnesota High School, Minneapolis, Minnesota; University of Chicago High School; University of Chicago; and New York University since 1928. He is a

Fellow in the American Association for the Advancement of Science.

Professor Pieper is the author of a number of articles in science education and coauthor of textbooks in general science and biology. This series of textbooks introduced the unit idea in science textbooks, a feature typical of most textbooks since that time.

For many years Mr. Pieper was Editor of *Science Education,* succeeding Mr. Walter G. Whitman who had been its Editor under the name *General Science Quarterly.* In his capacity as Editor, Mr. Pieper made a most valuable contribution to science education and set standards of workmanship that have been difficult to emulate.

He is a former member of the Executive Committee and Vice-President of NARST.

President Wheeler read the following messages from members not attending the dinner meeting:

Charles J. Pieper:

My warmest congratulations to the "old guard" of NARST for their outstanding contributions to the teaching of science—and best wishes to those of the younger group in whom is vested our trust that they will fulfil their loftiest ambitions in the profession of science education.

Personal greetings to all.

Archer W. Hurd:

I want to express my appreciation and thanks for the invitation extended to me to attend the Silver Anniversary Meetings of the N.A.R.S.T. I cannot attend in person as I had planned, but you may be sure I shall be there in spirit. I am sorry to miss seeing you all again, but hope you may have a splendid meeting and enjoy the celebration of the Silver Anniversary.

I shall miss the opportunity of getting back into the activities which I so much enjoyed in the beginning days of N.A.R.S.T. Your many kindnesses will always be remembered.

Harry A. Cunningham:

I do hope that you have a fine meeting. The organization has made a wonderful contribution in 25 years.

Frank C. Jean:

Hope you have a big time, as I know you will.

Walter G. Whitman:

Sorry to miss the Chicago meeting.

N. H. Black:

Sorry I shall not be able to attend your meeting.

Gerald S. Craig:

Wish I could be with you. The Boston meeting of ASCD conflicts with the Chicago meeting of NARST.

John A. Hollinger.

The charter members did well in the beginnings of NARST. We wish the best of luck to those who are carrying on the good work. Please extend our kind regards to all, especially the old timers. Science teaching has made progress but not enough.

Edward E. Wildman:

With kind regards to all my old friends, and best wishes to you younger men who are carrying the burden of the work for the Association.

NEW MEMBERS OF NARST

The following persons have been elected to membership in The National Association for Research in Science Teaching by an affirmative vote of the members.

SAM S. BLANC
East High School
Denver, Colorado

MURIEL BEUSCHLEIN
6431 S. Richmond
Chicago 29, Illinois

MAURICE BLEIFELD
56-23—219th Street
Bayside 64, New York

BLANCHE G. BOBBITT
415 N. Hill Street
Los Angeles 12, California

STANLEY B. BROWN
School of Education
University of Colorado
Boulder, Colorado

MARJORIE HAINES CAMPBELL
1501 Tea Street S.E.
Washington, D. C.

JAMES M. ELLIOTT
RFD #2
Box 56A
Lansing, Michigan

L. PAUL ELLIOTT
University of Florida
Gainesville, Florida

ROLLAND JAMES GLADIEUX
Supervisor of Science
Kenmore, New York

WILLIAM F. GOINS
Tennessee A & I College
Nashville, Tennessee

HOWARD W. GOULD
Northern Illinois State College
DeKalb, Illinois

HELEN W. HARVEY
Junior High School
Stillwater, Minnesota

NELSON L. LOWRY
Arlington Heights Township High School
Arlington Heights, Illinois

JOSEPH MINDEL
17 Chittenden Avenue
New York 33, New York

Members seated at the Speaker's Table (left to right): W. L. Eikenberry, Clarence E. Baer, E. Laurence Palmer, Earl R. Glenn, N. Eldred Bingham, Ralph K. Watkins, S. Ralph Powers, Francis D. Curtis, Betty Lockwood Wheeler, F. Atherton Riedel, C. L. Thiele, Hanor A. Webb, and Ira C. Davis.

Seated at Tables—counterclockwise both as to Tables and as to seating:

Table One—Muriel Beuschlein, R. L. Taylor, Mrs. Eugene Irish, E. Eugene Irish, Vaden W. Miles, Mrs. W. L. Eikenberry, Mrs. Clarence E. Baer, and Richard L. Weaver.

Table Two—John M. Mason, John A. Woodburn, Bertha Whitmore, John C. Chiddix, Alfred D. Beck, William B. Reiner, and Mary Alice Burmester.

Table Three—Milton O. Pella, Helen W. Harvey, Philip G. Johnson, Greta Oppe, Harley F. Glidden, Herbert S. Zim, Dorothy Phipps and George C. Phipps.

Table Four—Frank K. Harmon, John H. Jensen, Clarence H. Boeck, John S. Richardson, Robert H. Carleton, Ralph W. Lefler, G. P. Cahoon and Truman L. Hall.

Table Five—Vernon C. Lingren, Harold E. Sturm, Herbert A. Smith, Kenneth E. Anderson, David J. Miller, Jacqueline Buck, James L. Pellowe, and Robert A. Bullington.

Table Six—Thomas P. Fraser, W. W. E. Blanchet, Clyde M. Brown, W. C. Van Deventer, George G. Mallinson, Charles W. Hoffman, Clifford G. McCollum, and Leland L. Wilson.

Table Seven—J. Darrell Barnard, George C. Seville, Ernest E. Snyder, William W. Roso, Mrs. Mildred S. Crouch, Hubert B. Crouch, and Clarence M. Pruitt.


SILVER ANNIVERSARY DINNER MEETING
CONGRESS HOTEL - FEBRUARY 15, 1952
OSCAR
CHICAGO
52-6069-A

THOMAS C. POLSON
School of Education
University of California
Berkeley, California

OREN R. RANKIN
Division of General Studies
College of Liberal Arts and Science
University of Illinois
Urbana, Illinois

CLYDE T. REED
University of Tampa
Tampa, Florida

HERMAN SCHNEIDER
40 Bank Street
New York 14, New York

MARVIN D. SOLOMON
Department of Natural Science
The Basic College
Michigan State College
East Lansing, Michigan

ROY W. STANHOPE
The Teachers College
Newtown, N.S.W.
Australia

DAVID W. STOTLER
2834 N.E. 38th Avenue
Portland 13, Oregon

MELVINA TRUSSELL
2011 Lee Avenue
Tallahassee, Florida

STANLEY E. WILLIAMSON
Oregon State College
Corvallis, Oregon

Other changes in position by NARST members:

WILL SCOTT DELOACH
Del Mar College
Corpus Christi, Texas
(from Mississippi State College for Women, Columbus, Mississippi)

GORDON M. DUNNING
Rt. 1, Box 455
Annandale, Virginia
(from State Teachers College at Indiana, Pennsylvania)

WILLIAM C. FORBES
Willimantic State Teachers College
Willimantic, Connecticut
(from State Teachers College at Troy, Alabama)

E. EUGENE IRISH
Audio-Visual Education Center
4028 Administration Building
University of Michigan
Ann Arbor, Michigan
(from Ball State Teachers College, Muncie, Indiana)

OLIVER S. LOUD
25 Chaske Avenue
Auburndale 66, Massachusetts
(from Antioch College, Yellow Springs, Ohio)

CHARLES J. PIEPER
220 Drake Avenue
New Rochelle, New York
(formerly School of Education, New York University, New York, New York)

S. RALPH POWERS
90 Adams Avenue
Haworth, New Jersey
(from Teachers College, Columbia University)

F. ATHERTON RIEDEL
Box 36
High Point College
High Point, North Carolina
(from Sapulpa, Oklahoma)

FRANCIS J. ST. LAWRENCE
Lindbergh Junior High School
Long Beach, California
(from Bristol High School, Bristol, Connecticut)

RICHARD L. WEAVER
School of Natural Resources
University of Michigan
Ann Arbor, Michigan
(from North Carolina Dept. of Public Instruction, Raleigh, North Carolina)

EDWARD K. WEAVER
Florida Normal and Industrial Memorial College
St. Augustine, Florida
(from Bishop College, Marshall, Texas)

THE THIRTY-FIRST YEARBOOK IN RETROSPECT AND WITH A LOOK TO THE FUTURE *

Samuel Ralph Powers

Chairman of Yearbook Committee, Teachers College, Columbia University, New York, New York

The reconstruction of educational theory is a continuous challenge to educators. From time to time general committees prepare and issue reports to reintepret the broad aspects of theory and to redirect practice. The Educational Policies Committee of the National Education Association is such a one. Similarly special committees may be appointed to serve these functions within a particular area of work, for example in the area of science teaching. As a case in point the National Society for the Study of Education appointed in 1930, its Committee on the Teaching of Science with instructions "to deal primarily with the course of study in science in the public schools, with some attention to methods of instruction and to the training of teachers."

The members of this Committee who assumed the main responsibilities for the Thirty-first Yearbook of the National Society have been asked to say whether we believe now, in 1952, what we wrote in 1932 and to explain why we have or have not changed our views. We have had neither the opportunity, nor the desire to compare our ideas in preparation for this presentation. Therefore each view expressed is that of the individual speaker.

I do, however, speak for all, I believe, when I say we thought then, and in retrospect we think now, that our report was well in agreement with educational theory as of 1932. Our challenge was to interpret theory as it was applicable to the teaching of science and to give direction to planning so as to bring practices in education in this area in agreement with the interpretation. The need for planning was clear. There was an obvious educational lag. Groups of science educators guided in their work by conflicting and often out-moded conceptions of education were opposing each other and were making for disunity where common interests, if clearly interpreted, would lead to cooperation to achieve common purposes. A plain task for the Committee was to help science educators to resolve these conflicts.

There were differences in opinions between those who advocated the teaching of nature study and those who advocated elementary science, and between those supporting general science and those who favored courses in special sciences. This latter group had the support of tradition. It was at about this time that a well-known physicist had "prayed to God for forgiveness" for the part he had played in advancing general science. It was easy to see that people with potentially common interests were not cooperating and largely because they had no common grounds for a meeting of minds. The Committee took for its main task, to present "a general plan for an integrated program of science teaching."

It was reasonable that we should look to the unity in science for themes or generalizations about which we could construct an integrated plan. On account of the common interests among science teachers in the meanings of science, it seemed reasonable that these broad themes might suggest the needed "grounds for the meeting of minds." This notion was not entirely novel for educators generally were looking for big ideas that would be useful in the process of synthesizing ideas and practices that belong together in the education of young people.

The selected major generalizations of science were thought of as descriptions of environment and of processes and were

* Presented at Twenty-fifth Anniversary of National Association for Research in Science Teaching, Congress Hotel, Chicago, Illinois, February 15, 1952.

seen as so important and so extensive in scope that students may with profit live with and learn about them throughout life. The underlying assumption about learning "is that children (and adults) learn from experience and that the process of learning involves the association of related experiences into increasingly enlarged understandings." It was explained that, "as the child progresses through the schools, he gets an increasingly enlarged understanding of the world in which he lives and of the problems associated with living." It was assumed that these large generalizations, selected with reference to their social relations, would furnish a drive toward the achievement of better adjustments in life. These suggestions did indeed prove to be the basis of a plan for integrating the study of science. There can be little doubt that this plan did affect far-reaching influences on thinking and planning about the scope and meaning of science and on methods of teaching.

This integration principle seemed sound to us in 1932, but in 1952 it seems inadequate. We were at that time led into the methodological error of assuming that we could select subject matter by some social criterion and successfully assign it as subject matter to be learned. The suggested practice, however, was certainly in advance of the more traditional one of assigning subject matter without recognition of human-relations. There is much in common in the human-relations interests held by members of a group. When this common interest is discovered the problematic situations that arise from the group will be recognized as generally significant and challenging to all of them. There is it seems still good support for the conclusion that situations to be recognized as significant by all students are more likely to arise out of subject matter selected on the basis of human relations than when selected on the basis of the logic of organized research. The error was that the Committee did not go far enough. The recommendations were effective in keeping attention centered upon the study of organized subject matter. They made no adequate provision for recognizing common interest and consequently neglected the problematic situations which arise spontaneously from the activities of young people in the process of their growth and development. In too large a measure science was left in the curriculum as subject matter to be learned—to be used at a later time—rather than as a resource to be used in dealing with situations of immediate interest.

We believe now that young people, and old as well, learn only that for which they feel a need. A person cannot successfully be directed to do an assigned task unless the task is accepted by him as important. Education cannot be given. It must be gained. Motives are not given. They are discovered. Motives are intrinsic. It is tenable to take the position now, that regardless of how deeply the selected subject matter "ramifies into human welfare" there is no such ramification for the learner until he personally discovers its necessary relation to his own welfare. In this event the learner recognizes the subject matter as a resource, useful to him in dealing with a situation which is his own. Educational theories of today encourage us to neglect generalizations and socially significant subject matter as primary learnings and to turn at once to studies of young people with recognition of the problematic situation they face. The generalizations important in the lives of people are those which eminate as concomitants of their learning to deal successfully with their own developmental tasks. We recognize now that the process of education is in large part one of getting our bearings, of gaining orientation in the world of things and people. We are learning to think of science as subject matter that contributes much to this continuing process.

The contribution from the work of scientists is a description of environment. This description is dependable in the sense that we can base predictions upon it and thus give order and direction to our lives. All observed phenomena are studied and

the results are statements of relationships. There are dependable descriptions of the motion of the heavenly bodies, of changes on the surface of the earth, of life and growth, of human behavior, and of all manner of things and processes that are observable. All the aspects of nature may be seen as related. As a result, the world has been described as "of one piece." We gain orientation as we learn to relate our own behavior to the dependable descriptions of the world of things and people. This orientation enables us to plan our actions and to predict consequences of what we do.

It may be observed that people, young and old, endeavor to direct their actions in agreement with their comprehension of environment. Their actions may be described as orderly in so far as they can predict from them the consequences of what they do. When they are unable to predict consequences, their actions will be chaotic; they will be acting blindly.

Many false statements of relationship affecting human behavior have persisted as a heritage from the folklore of the past. These include such false statements of relations as that of the ground hog and the weather, the dowser's stick and underground water, and a zodiacal sign and the future behavior of a new-born infant. The urge to find some kind of guide to action, that is some kind of orientation, is seen in the eagerness with which men depend for their guidance, in matters often of great consequences, on such signs and omens.

Scientists have learned to examine statements of relationships and to determine which ones are dependable as guides to action. This ability is not altogether in the domain of specialists. All people display it more or less. It is in fact a part of biological heritage. As people gain in this ability they will shift in their ways of thinking and behaving away from action that is guided by irrational statements of relations in the direction of action that is in agreement with orderly and dependable descriptions of the world.

In this point of view science must be seen in its broad relations. The scope of science will be as broad as the scope of activities of the learner. We shall slowly abandon the study of special areas of science as part of general education. Descriptions, still current, of learning as *fait accompli*, and applied to subject matter, scientific methods, and attitudes are not dependable as guides in education. These terms have come to be but little more than *cliches*. Learning is more dependably described as process, and will be thought of as going on as people engage in the tasks important for them at their age and in their place. The Thirty-first Yearbook of the National Society was a step in transition; the Forty-sixth Yearbook has carried on. Young educators are now making recommendations for further changes and from these, in the not distant future, another "Yearbook" will be constructed.

NARST MEMBERS IN FOREIGN SERVICE

The following members of NARST are in foreign service during 1952–53.

Dr. H. Emmett Brown is doing educational work in Formosa. His address is: MSA Formosa, APO 63, c/o Postmaster, San Francisco, California.

Professor Earl R. Glenn has a Fulbright teaching assignment for the next two years in the Philippines. He may be contacted through The United States Educational Foundation in the Philippines, The American Embassy, Manila, Philippines.

Elwood D. Heiss has been commissioned by UNESCO to spend a year in Thailand as a specialist in Science Education. His present address is in care of Ministry of Education, Bangkok, Thailand.

Vernon C. Lingren is in Tripoli, Libya. He may be reached through American Legation, APO 231, c/o P.M., New York, New York.

THE THIRTY-FIRST YEARBOOK IN RETROSPECT AND WITH A LOOK TO THE FUTURE *

Francis D. Curtis

Member of Yearbook Committee, University of Michigan, Ann Arbor, Michigan

Until I heard Ralph Powers just now, I hadn't realized how far apart in our professional thinking he and I had drifted. I realize with complete astonishment, that his point of view (if I correctly interpret it) and mine, are almost diametrically opposed.

In trying to present my opinions with regard to Thirty-first Yearbook, I am working under a sizable handicap, because I have only a few notes. Ralph has just read the manuscript of a carefully prepared speech. I had the idea that we panel members were expected to present our views in a conversational discussion. I should like, however, to make a few statements for whatever they may be worth, and to make them in the spirit of the very friendly relations which Ralph and I have maintained during nearly thirty years.

It seems to me a wholly justifiable and logical conclusion that, if we were to accept and carry out Ralph's plan, we should reduce the teaching of science at all levels to a chaotic state of on-the-spot trial and error. Such desirable outcomes as might result would be achieved only by chance. They could hardly result otherwise than incidentally and accidentally. The basic fallacy in such a program, as it seems to me, lies in its total lack of direction toward definitely defined major goals. It is a program of specifics, and no combination of school experiences could be made to provide enough specific items to contribute certainly and thoroughly to education for later life.

I believe that our present trends in educational thinking justify our saying that the primary purpose of modern curriculum making is to provide *training*—training of the sort that our best judgment indicates to be desirable for its potential values to every individual as long as he may live. What is commonly *called* the curriculum is an assemblage of sequences of courses and of course outlines that call for the use of textbooks, experiences of the sort that Ralph has described, and all the other materials and activities that good teachers use. But these are not the curriculum at all. Essential as such tools unquestionably are, they are not ends, but means. They can serve only as the means by which we can hope to make every course contribute its share to the fundamental training that constitutes education. Is it not logical, therefore, to state that the major objectives (which are areas of desirable training) must serve as guides to the selection and implementation of all the experiences that we provide in our schools? If I have interpreted Ralph's statements correctly, definite contributions to training of this sort could not certainly be achieved through his program, because it lacks major goals.

With respect to the Thirty-first Yearbook, of course it is out of date in many respects. The chapters in which I attempted to review the research of that period, are now hopelessly antiquated. Of course they are. Time has passed and there has been substantial progress in many respects. But the fundamental objectives of science education, the pegs on which to hang our teaching achievements from day-to-day and year-to-year, are still sound. Scientific generalizations, or principles, are now, as in 1932, indispensable foundations of every science course at any level. These

* Presented at Twenty-fifth Anniversary of National Association for Research in Science Teaching, Congress Hotel, Chicago, Illinois, February 16, 1952.

principles give direction, orientation, and guidance toward what we hope to achieve. Of course they are of little or no value if they are presented ready-made, to be learned as memory gems; but if, we plan and direct the experiences with a conscious knowledge of the ultimate targets that we are shooting at, then there is a good chance that we shall be able to teach in each course, functional understandings of some, at least, of the principles that we have selected as appropriate.

These statements of mine admittedly reveal a firm belief that there is some transfer of learning; but all our educational program would be ghastly and futile if we did not believe that there is some transfer from the class-room and other teacher-directed experiences, to real-life situations.

Emphasis on the scientific attitudes, like that on scientific principles is not outmoded. The scientific attitudes have now been defined by enough investigators so that we know what they are. It is discouragingly difficult to inculcate them in boys and girls to the extent that the latters' subsequent behaviors will reflect them. But there is no hope if we assume a defeatist attitude toward attempts at such inculcation. (I well remember, Ralph, that you objected to my use of "inculcate" in this connotation, in 1931, as no doubt you would now). We must "keep on a-keepin' on" in our efforts to achieve this goal as we do in trying to achieve anything else that is worthwhile. If we can succeed, then we can have some hope of combating effectively intolerance, bigotry, provincialism, gullibility and many other undesirable social traits and manifestations. Furthermore, I believe that because of the nature of our training and of the materials with which we work, we can do a better job of inculcating people with scientific attitudes than can the teachers in other fields.

There is a third major objective of science education, namely, that of developing skill in the use of scientific method, that we did not emphasize in the Thirty-first Yearbook. We were groping for it, as there is evidence in the book to show. But the elements of scientific method had not yet been identified as being separate and distinct from the scientific attitudes. This identification came later and has had wide use in problem solving at all grade levels.

Now, if we assume that the heart of any curriculum is the *training* that it can contribute; if we further assume that there are, after all, only three different *classes* of objectives, namely, first, those that deal with subject matter (which, in our field, would be primarily the principles of science); second, those that involve the emotions (which, in our case, would prominently include the scientific attitudes); and third, those that include the skills (which in our case are represented primarily by the elements of scientific method), then we have three major goals of science teaching, two of which were announced and the other indicated in the Thirty-first Yearbook. These goals are, in my thinking, perennial and paramount.

THE THIRTY-FIRST YEARBOOK IN RETROSPECT AND WITH A LOOK TO THE FUTURE *

Ralph K. Watkins

Member of Yearbook Committee, University of Missouri, Columbia, Missouri

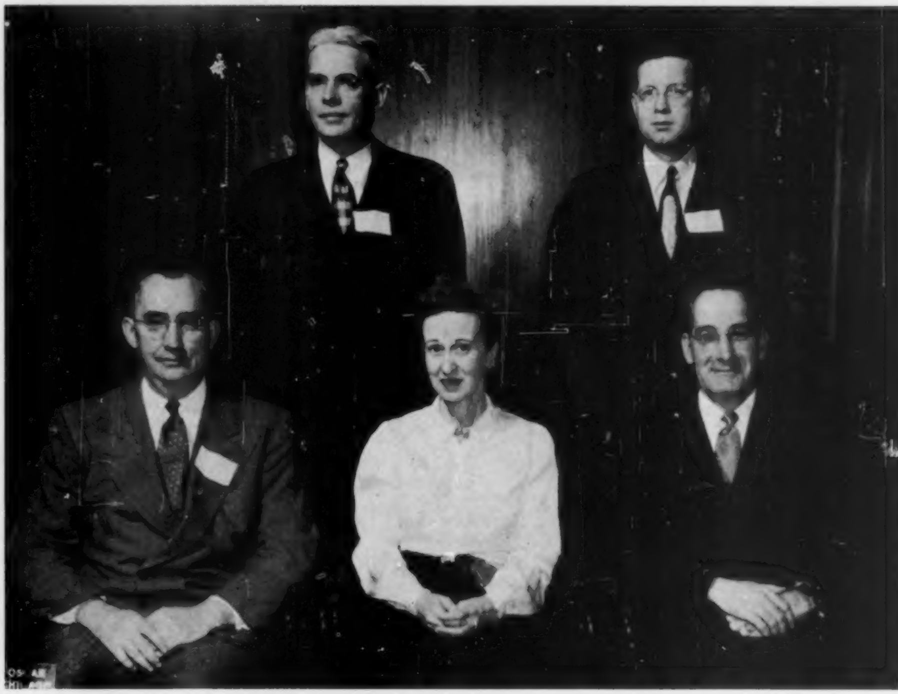
It is evident that this part of the program was not rehearsed. We didn't get together to make an agreement. As I recall the early stages of the development of the 31st Yearbook, one of the things upon which we did agree was that we should put in the 31st Yearbook those things upon which we, as a committee, could pretty well agree. I think that perhaps the significant thing that we did agree upon was that we could make a contribution to the synthesis of science by trying to build a science program around the notion of generalized principles. I believe that approach is still sound and probably the three of us would agree to that now.

Dr. Powers will remember that Charles Pieper and I were in the minority on this committee. We protested the acceptance of the generalizations as objectives, to which point of view Dr. Powers has arrived in the program tonight.

I would say to Dr. Barnard that I have an acute realization that Moses brought the tables of the law to a very primitive society, that the society in which we live has changed. I would call to mind, to a group of scientists and science teachers, that what has happened in our scientific world is a pyramiding of our scientific knowledge. If you know one thing, you can do 100. If you know 100, you can do 10,000 and so on, which means that our science and our changes in civilization have moved very rapidly in these twenty years.

So, I would like to say that a new yearbook committee would think of a program, perhaps hung on Francis Curtis' pegs and generalizations, but with an acute awareness that we must master the inventions, the discoveries and the machines of our age, or we disappear in the process; that's the social point of view, and that we would then have a new yearbook committee, which would probably not consist of the oldsters, re-think the whole situation. I would throw out our chapter on the psychology of science education and I would have modern scientists review the generalizations in terms of the science which has developed in these twenty years. Our science and our psychology are almost entirely outmoded, so I would like to free the new yearbook committee, our younger generation, to work in its particular society, to set a new framework.

* Presented at Twenty-fifth Anniversary of National Association for Research in Science Teaching, Congress Hotel, Chicago, Illinois, February 15, 1952.



Officers of Silver Anniversary NARST Meeting—Clarence M. Pruitt (Secretary-Treasurer); Betty Lockwood Wheeler (President); J. Darrell Barnard (Vice-President); N. Eldred Bingham (Member of Executive Committee); and George G. Mallinson (Member of Executive Committee).

TWENTY-FIFTH ANNUAL MEETING

NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

February 14, 15, and 16, 1952
Congress Hotel, Chicago, Illinois

PROGRAM

THURSDAY, FEBRUARY 14, 1952

9:00-10:00 A.M. Registration—Parlor D

9:00-10:00 A.M. Executive Committee—Parlor E
Graduate Program—Parlor A and B

10:00-10:15 A.M. Greetings by George G. Mallinson, Chairman of the Graduate Program.

10:15-11:00 A.M. *The Beginnings, Early Membership, and Early Activities of NARST.* Ralph K. Watkins, University of Missouri, Columbia, Missouri.

11:00-11:45 A.M. *The Growth and Activities of NARST.* Hanor A. Webb, George Peabody College for Teachers, Nashville, Tennessee.
11:45-12:00 Questions.
12:00-2:00 P.M. Luncheon and Intermission.
2:00-2:30 P.M. Introduction of Officers of NARST.
2:30-3:15 P.M. *Research and Research Activities of the NARST and Its Membership.* Francis D. Curtis, University of Michigan, Ann Arbor, Michigan.
3:30-4:45 P.M. Graduate Student and NARST Informal Mixer—Pine Room.
7:30-9:30 P.M. Special Committee Meetings.
Parlor G—Atomic Energy Committee, Jerome Metzner and Abraham Raskin, Co-Chairmen.
Parlor E—Elementary Committee, N. Eldred Bingham, Chairman.
Parlor F—Junior High School Committee, Earl R. Glenn, Chairman.
Parlor D—Senior High School Committee, Kenneth E. Anderson, Chairman.
Parlor L—Problem Solving Committee, J. Darrell Barnard, Chairman.
Parlor M—College Committee, W. C. Van Deventer, Chairman.
Parliament Room—Educational Trends Committee.

FRIDAY, FEBRUARY 15, 1952

Investigations and Research Studies, Parlors A and B, Clarence M. Pruitt, Chairman.
9:00- 9:15 A.M. *A Student Evaluation of an In-Service Elementary Science Workshop.* N. Eldred Bingham, University of Florida, Gainesville, Florida.
9:15- 9:30 A.M. *Science Information and Attitudes Possessed by California Elementary School Pupils.* Stanley B. Brown, University of Colorado, Boulder, Colorado.
9:30- 9:45 A.M. *A Determination of Materials Dealing with Soil Conservation and Suitable for Integration into Courses of High School Science for General Education.* E. Eugene Irish, Ball State College, Muncie, Indiana.
9:45-10:00 A.M. *An Item Analysis of the New York State Regents Examinations in Earth Science. Part I.* James E. Pellowe. Portage High School, Portage, Michigan.
10:00-10:15 A.M. *An Item Analysis of the New York State Regents Examinations in Earth Science. Part II.* Jacqueline Buck, Farmington Township High School, Farmington, Michigan.
10:30-10:45 A.M. *Interpretation of a Science Interest Questionnaire.* Sam S. Blanc, Denver Public Schools, Denver, Colorado.
10:45-11:00 A.M. *The Inductive Compared to the Deductive Approach to Teaching Secondary Chemistry.* Clarence H. Boeck, University of Minnesota, Minneapolis, Minnesota.
11:00-11:15 A.M. *Early Interests and Activities of Professional Scientists.* Herbert S. Zim, University of Illinois, Urbana, Illinois.
11:15-11:30 A.M. *Science Interests of Junior College Girls as Determined by Their Reading in Current Science.* Clyde M. Brown, Southern Illinois University, Carbondale, Illinois.
11:30-11:45 A.M. *Status and Trends in the Field of Atomic Energy in the Education of Science Teachers.* Truman Hall, Ohio State University, Columbus, Ohio.

Investigations and Research Studies. Parlors A and B, J. Darrell Barnard, Chairman.

1:30-1:45 P.M. *General Education Science in Southern Association Junior and Senior Colleges.* Leland L. Wilson, Eastern Kentucky State College, Richmond, Kentucky.

1:45-2:00 P.M. *Desirable Competencies for Instructors of College General Education Courses in Physical Science.* Oren R. Rankin, University of Illinois, Urbana, Illinois.

2:00-2:15 P.M. *Performance Tests in Physics at the University of Minnesota.* Haym Kruglak, University of Minnesota, Minneapolis, Minnesota.

2:15-2:30 P.M. *An Experimental Study in the Teaching of Scientific Thinking in the Biological Sciences at the College Level.* John M. Mason, Michigan State College, East Lansing, Michigan.

2:30-2:45 P.M. *The Construction and Validation of a Test to Measure Some Aspects of the Ability to Think Scientifically.* Mary Alice Burmester, Michigan State College, East Lansing, Michigan.

2:45-3:00 P.M. *A Method Course for Prospetcive College Teachers of the Biological Sciences.* Richard R. Armacost, Purdue University, Lafayette, Indiana.

3:30-5:30 P.M. Special Committee Meetings.

Parlor G—Atomic Energy Committee.
Parlor E—Elementary Committee.
Parlor F—Junior High School Committee.
Parlor D—Senior High School Committee.
Parlor L—Problem Solving Committee.
Parlor M—College Committee.
Parliament Room—Educational Trends Committee.

6:30 P. M. Annual Dinner Meeting. Florentine Room. N. Eldred Bingham, Chairman.

Recognition of Charter Members of NARST. Betty Lockwood Wheeler, President of NARST.

Panel: Looking Back Twenty Years at the N.S.S.E.

Yearbook, Part I. *A Program for Teaching Science.*

Introduction of the members of the panel, J. Darrell Barnard.

Chairman of panel: S. Ralph Powers, Teachers College, Columbia University, New York, New York (Chairman of the Yearbook Committee).

Panel Members:

Gerald S. Craig, Teachers College, Columbia University, New York, New York. (Members of Yearbook Committee).

Francis D. Curtis, University of Michigan, Ann Arbor, Michigan. (Member of Yearbook Committee).

Charles J. Pieper, New York University, New York, New York. (Member of Yearbook Committee).

Ralph K. Watkins, University of Missouri, Columbia, Missouri. (Member of Yearbook Committee).

SATURDAY, FEBRUARY 16, 1952

Investigations and Research Studies, Parlors A and B. Betty Lockwood Wheeler, Chairman.

9:00-9:15 A.M. *The Subject Matter Content of General Education Science Courses.* Robert A. Bullington, Northern Illinois State Teachers College, DeKalb, Illinois.

9:15-9:30 A.M. *Laboratory Teaching in the Basic Science Courses.* W. C. Van Deventer, Stephens College, Columbia, Missouri.

9:30-9:45 A.M. *Needed Research in Science Evaluation.* William B. Reiner, New York City Board of Education, Brooklyn, New York.

9:45-10:00 A.M. *Improving Science Teaching Through Realistic Research.* Kenneth E. Anderson, University of Kansas, Lawrence, Kansas.

10:00-10:15 A.M. Bibliography with Annotations for Science in General Education 1951. Vaden Miles, Wayne University, Detroit, Michigan.

10:15-10:30 A.M. Studies in Rigidity and the Scientific Method—Marvin D. Solomon, Michigan State College, East Lansing, Michigan.

10:30-11:00 A.M. Business Meeting.

A REPORT TO THE NARST ON THE ACTIVITIES FOR 1951–2 OF THE COOPERATIVE COMMITTEE ON THE TEACHING OF SCIENCE AND MATHEMATICS OF THE AAAS *

GEORGE GREISEN MALLINSON

Western Michigan College of Education, Kalamazoo, Michigan

IN accord with the policy adopted at the two previous meetings in presenting the report of the activities of the Cooperative Committee of the AAAS, it was decided to present this report in two sections, (1) a summary of the more important activities, and (2) for each member of the NARST a brochure that contains all the minutes, publications and activities of the Cooperative Committee for the year 1951–2.

PERSONNEL OF THE COOPERATIVE COMMITTEE

Unlike last year the personnel of the Cooperative Committee remained fairly stable. One change involved the appointment of two representatives for the American Astronomical Society, one of whom will represent the society at the fall meeting in the East, and the other, at the spring meeting in the Midwest. Another change involved the replacement of Dr. Glidden S. Baldwin by Mr. Richard L. Weaver as representative for the American Nature Study Society. In addition, the American Geological Institute appointed Dr. Arthur S. Howland as its representative.

At present the Cooperative Committee consists of the following persons:

1. American Association of Physics Teachers and the U. S. Office of Education
   Dr. Bernard B. Watson, Secretary
   Division of Higher Education
   U. S. Office of Education
   Federal Security Agency
   Washington 25, D. C.
2. American Astronomical Society
   a. Dr. Thornton Page (Chicago meeting)
   Yerkes Observatory
   William Bay, Wisconsin

* Report of the NARST representative on the Cooperative Committee made at the Silver Anniversary Meeting of the NARST at Chicago, Illinois, February 16, 1952.

b. Dr. Fletcher Watson (Eastern meeting)
Graduate School of Education
Harvard University
Cambridge, Mass.

3. American Chemical Society
Dr. C. H. Sorum
Department of Chemistry
University of Wisconsin
Madison 6, Wisconsin

4. American Institute of Physics
Dr. J. W. Buchta
Department of Physics
University of Minnesota
Minneapolis, Minnesota

5. American Nature Study Society
Mr. Richard L. Weaver, Secretary
Resource-Use Education Commission
N. C. Dept of Public Instruction
P. O. Box 5424
State College Station
Raleigh, N. C.

6. American Society of Zoologists
Dr. L. V. Domm
Hull Anatomical Laboratory
University of Chicago
Chicago 37, Illinois

7. Botanical Society of America
Dr. Glenn W. Blaydes
Department of Botany
Ohio State University
Columbus, Ohio

8. Central Association of Science and Mathematics Teachers
Mr. Donald W. Lentz, Principal
Ridge Road School
6726 Ridge Road
Parma 29, Ohio

9. Division of Chemical Education of the American Chemical Society
Dr. Laurence L. Quill
Department of Chemistry
Michigan State College
East Lansing, Mich.

10. Executive Committee of the American Association for the Advancement of Science
Dr. W. S. Hunter
Brown University
Providence 12, R. I.

11. American Geological Institute
Dr. Arthur L. Howland, Chairman
Department of Geology
Northwestern University
Evanston, Illinois

12. Mathematical Association of America
Dr. J. R. Mayor
Department of Mathematics
306 North Hall
University of Wisconsin
Madison 6, Wisconsin

13. National Association of Biology Teachers
Mr. Prevo L. Whitaker
University School
Indiana University
Bloomington, Indiana

14. National Association for Research in Science Teaching
Dr. George G. Mallinson
Professor of Psychology and Education
Western Michigan College of Education
Kalamazoo, Michigan

15. National Council of Teachers of Mathematics
Mr. George H. Hawkins
Lyons Township High School and Junior College
LaGrange, Illinois

16. National Science Teachers Association
Dr. Morris Meister, Chairman
Principal, High School of Science
120 East 184th Street
New York 68, N. Y.

17. Section Q (Education) of the American Association for the Advancement of Science
Dr. Francis D. Curtis
School of Education
University of Michigan
Ann Arbor, Michigan

ACTIVITIES AT THE SPRING MEETING

The spring meeting of the Cooperative Committee was held at the International House, University of Chicago, May 5–6, 1951. A number of major activities and discussions were undertaken. They were as follows:

1. *The Manpower Situation.* After routine business matters were attended, Dr. Philip N. Powers of the National Security Resources Board reported on the supply of engineering and technical manpower likely to be available for the period 1951–54. The startling fact was revealed that the supply of college graduates in the areas mentioned for 1954 would be about one-tenth of that available in 1950. The Cooperative Committee discussed the various implications of the problem and agreed that some effort should be made to increase the percentage of students electing scientific and technical careers, and that a special effort should be made to dispel the notion that the scientific and technical fields were ever overstocked with manpower. It was decided that the members should survey the possibilities of help from their own socie-

ties, and be prepared to offer specific recommendations at the fall meeting.

2. *The National Committee on Science Teaching.* A great amount of time was devoted to a proposal in a joint memorandum from Robert Carleton, Executive Secretary of the National Science Teachers Association and Harry W. Charlesworth, Acting Executive Secretary of the National Council of Teachers of Mathematics. The proposal suggested that the support of the Cooperative Committee be enlisted in approaching the Ford Foundation for funds to undertake a large scale study of the teaching of science and mathematics. There was considerable discussion of this proposal as well as of another proposal by Philip Johnson of the U. S. Office of Education for a similar study incorporating also the social implications of science. The grant in funds would involve a sum of about one million two hundred thousand dollars ($1,200,000).*

Dr. Meister was then delegated together with Dr. Mayor to attend a meeting called for May 12, 1951 in Washington to explore further the proposals for Ford Foundation support of the science teaching studies. Dr. Meister was instructed to present the following viewpoints expressed by the Cooperative Committee. They are as follows:

1. That any National Commission on Science Teaching appointed to carry out the study proposed should be established under the auspices of the four organizations mentioned in this connection in the Steelman report—the American Association for the Advancement of Science, the American Council on Education, the National Education Association and the U. S. Office of Education.

2. That among the groups which should be included in an advisory category are groups such as the American Chemical Society, the American Medical Association, the Atomic Energy Commission, the National Science Foundation, the American Institute of Biological Sciences, the American Mathematical Society, the American Association of School Administrators, the Chief State School Officers, the Association for Supervision and Curriculum Development of the N.E.A., the Teacher Training Division of the N.E.A., the Department of Education of the N.E.A., Business-Industry and Labor groups, in addition to the societies represented on the Cooperative Committee.

3. That the members of the National Commission should be men of the highest stature in the scientific and educational worlds, and should be representative of the various sciences and of the several levels of education and that their appointments should be for a period of time long enough to assure continuity in the policies of the Commission.

4. That the institutes, workshops, and studies planned should involve the member organizations of the Cooperative Committee as working groups and, in addition, should make use of local and regional groups in order to involve in these activities as many as possible of those who come into direct contact with pupils and students, and partly for the purpose of strengthening the local groups.

On Sunday morning, May 6, the Cooperative Committee split into four sub-committees to consider problems in four areas, namely, (1) scientific manpower and acceleration, (2) teacher training, (3) visual aids, and (4) curriculum. The main recommendations of these sub-committees are as follows:

SCIENTIFIC MANPOWER AND ACCELERATION

Current enrollments in science, engineering and mathematics indicate that the graduating classes in these fields will, in 1954, drop to less than one-third of the number graduating last summer. Any drafting of students which may occur will, of course, lower the figure still further and could lower it to less than ten percent of last

* A complete statement of the tentative proposal is found in the brochure.

year's graduates. Although no accurate information is available concerning the national need for scientific manpower in the years ahead, the bulk of last year's huge class (110,000) was absorbed into the economy before the current mobilization effort was under way (i.e. before Korea). Even if the need for scientific manpower does not increase beyond the current need, we face an inevitable and serious shortage of such manpower in the immediate future.

The last two years of high school, the first two years of college and the intervening summers is the critical period when youth makes decisions as to life careers. Hope for increasing the Nation's supply of scientific manpower lies therefore in a study of the forces which lead to career decisions during this four-year period. Realization of this hope also depends largely on the quality of teaching and on the programs of guidance supplied by the Nation's schools and colleges.

The AAAS Cooperative Committee on Science and Mathematics Teaching recognizes that the strength of the Nation during the coming decade depends in large measure upon the development of a program of action to determine the factors which are preventing able young people from entering upon and receiving training in science and technology. As these factors are determined suitable measures must be devised for counteracting their effects. If accelerated programs in high school or college or both are indicated for certain students, the effects of such programs must be thoroughly considered. Will the crowding of traditional curricula into shorter time intervals yield the high quality manpower we need? What kinds of curriculum reorganization and reorientation are called for in the light of present needs? Answers to these and other vital questions must be found.

For these reasons, we again call attention to our recommendations as set forth in the Steelman Report and to the importance at this time of establishing a National Commission on the Teaching of Science and Mathematics.

Teacher Training

It is recommended that the Cooperative Committee devote one or more sessions to a restudy of the recommendations of the 1946 Report relating to teacher training and certification with special emphasis upon implementation. Topics for restudy would include:

1. The need for the training program of prospective teachers to include work in content and methods for the general courses in mathematics and science.

2. The need to determine what special training in subject-matter content and instructional techniques is needed by elementary teachers for effectively teaching elementary science, and to encourage teacher-training institutions to provide such training.

3. The need for a five-year program for certification as a means of making possible adequate mathematics and science training for effective teaching.

4. The place of practice teaching in the program.

5. The place of in-service training.

6. The essential need for teacher-training institutions in their courses for prospective teachers of science and mathematics, and for the in-service training of teachers of these two subject matter fields, to stress the problems involved in discovering and guiding pupils, who possess strong potentialities for successful scientific careers.

Visual Aids

With regard to the AAAS Annual Science Theatre, the Cooperative Committee recommends that an effort be made to group films according to subject-matter field and according to professional interest. In particular, it is recommended that one or more programs be devoted to films suitable for instructional use.

The Committee further reaffirmed the

recommendation adopted at the Washington meeting that the members of the Cooperative Committee be encouraged to suggest films for showing at the annual Science Theatre.

CURRICULUM

The report of this sub-committee elicited a great deal of discussion with respect to the relative merits of the single-track and double-track systems of teaching science and mathematics.

The report of the sub-committee with respect to mathematics was accepted more or less without comment. However, for the first time, to the knowledge of your representative, there developed a major discussion of the attitude of the Committee with respect to the values of the two systems in teaching science. As a result the Committee expressed two points of view as listed below.

(a) *The Single-Track Approach.* In order to insure to every high-school pupil, whatever his potentialities are or his future may be, an acquaintanceship with major fields of science as a background both for future life and for further study in special branches of science, it is recommended that a three-year sequence of general education in science be required, to consist of general science in the eighth grade, general biology in the ninth grade, and general physical science in the tenth grade. Provision for further work in science would then be made by offering in the eleventh and twelfth grades such advanced specialized courses in the physical and biological sciences as the resources of the school could provide.

(b) *The Double-Track Approach.* It seems reasonable to expect that the secondary-school curriculum can and will provide at least three years of science for the non-college-bound student, and a four year science sequence for the college-bound. A great many favor a ninth-grade General Science course for both groups, with differentiation in the tenth grade. The remaining two years for the non-college-bound student can best be a year course in Biological Science followed by a year of Physical Science. For the college-bound group, the year of General Science can be followed by a year of Biology, a year of Chemistry, and a year of Physics. The latter program is a more realistic one, considering the present teaching staff, equipment and school organization. To give all students General Science, Biological Science, and Physical Science, and in addition open up elective science to the college-bound group, is a proposition which will not meet with great favor in most schools. It is too radical a step and calls for a type of teacher which is more than scarce at the present time. It may have the effect of keeping all students to a minimum of three years of science, denying the additional fourth year to the college-bound group.

Your representative, as indicated in last year's report,[1] supports the single-track approach and will continue to do so unless he is instructed to do otherwise by the NARST, or until sufficient evidence is obtained with respect to the value of the double-track system to warrant a change of opinion.*

With apologies for repetition, your representative would like to state again for emphasis (and he hopes for the final time) his views on the situation. This will be done by challenging certain statements in the paragraph concerning the double-track approach.

1. The report by Philip Johnson[2] indi-

[1] George Greisen Mallinson, "A Report to the NARST on the Activities for 1950–51 of the Cooperative Committee on the Teaching of Science and Mathematics of the AAAS." *Science Education*, XXXV (October 1951) 189–193.

* It might be stated *as an opinion,* that there was somewhat more direct verbal support from the members of the Cooperative Committee for the single-track system than for the double-track. However, this may be disputed by the proponents of the double-track.

[2] Philip G. Johnson, *The Teaching of Science in Public High Schools.* Office of Education, Bulletin 1950, No. 9. Washington: U. S. Government Printing Office, 1950. Pp. viii + 48.

cated that the typical high school consists of about 150–175 pupils. Further this typical school is staffed by seven persons one of whom is the administrator who teaches four periods per day. Anyone who is aware of these typical conditions can realize that such a school would find it almost impossible to offer a science curriculum that would provide even a complete single track. In general, from the ninth to twelfth grades the courses offered are general science, general biology, with physics and chemistry being offered on alternate years because of an insufficient number of registrants.

Your representative cannot conceive of two programs of science in such a school as being either administratively or financially feasible. It is doubtful whether the "college-bound" track would enroll enough students ever to have a class.

2. Assuming that a school were large enough to have two tracks, there is, to the knowledge of your representative, no research evidence to substantiate the values of the "college-type" courses as being greater than those of the general courses. In fact, the research evidence that is available indicates exactly the opposite.

3. It behooves us also to examine the success of double-track programs where they have been in operation. Your representative believes that the following report[3] speaks for itself:

"The examinations they were taking were the awesome 'selection tests'—Britain's new way of finding out just what sort of secondary education each child should have. If he does well, he will win a coveted 'place' in one of the 'grammar' schools, and there he will get a solid academic education that may eventually lead him to a university. If he does not do so well, he will be sent to a 'central' or 'secondary technical' school where he will spend more time on vocational training. The bottom 60% of the children will end up in a 'secondary modern' school. There, formal academic training is at a minimum. . . .

Even the Labor Party . . . had worried over the fact that 'the three types of schools are bound to inherit the old traditions of class segregation . . . (with) some children resentfully concluding that they are inferior to (those) attending grammar schools.' Last week the controversy boiled up anew when A. G. Hughes, chief inspector in the Education Officers' Department of the London County Council, published a book with some severe words for the whole tripartite idea.

'It is very doubtful,' said he, 'whether on the basis of tests we ought ever to dare to decide, at the age of ten, whether an intelligent boy with practical aptitude is destined to become an academic scientist via a grammar school or a practical engineer via a secondary technical school. . . . Is it right to segregate . . . dull and bright, bookish-minded and practical-minded pupils . . . during the impressionable and formative period of adolescence? . . . Is it right to determine the type of education so early without reference to the changes of interest that so often develop during adolescence?

Apparently some Britons thought it was not right. The trouble is that until the nation can afford enough 'comprehensive schools' to accommodate everyone, eleven-year-olds will have to go through the same ordeal that hit the little Londoners last week."

America has such "comprehensive schools" and can afford them. Should we then be willing to foster a type of education that has shown itself to be undesirable?

As yet, there is not sufficient evidence that it is even possible to segregate the college student from non-college student at the age at which the decision for the right track would have to be made.

4. Your representative disagrees unequivocally with the term "realistic" for reasons just mentioned as well as for others. The double-track would require a larger teaching staff, more equipment and admin-

[3] "Ordeal in London." *Time,* LIX (February 4, 1952), 55–6.

istration of an undemocratic dual system of education. As far as radical is concerned with respect to the single-track, it is the system now in vogue in the United States, although some internal changes may be desirable.

5. Actually your representative cannot see how the type of teacher would differ at all except in being a teacher of a double-track he would be teaching *one more course* than he would in the single, namely, *Biology* which apparently would be differentiated from *General Biology* at the sophomore level.

6. In addition, the evidence at the present time indicates that the percentage of students now taking the "college-bound" sciences is less than the percentage of students who are going to college and is growing smaller. Enrollments in the general education courses are increasing. How the problem can be solved by offering more of what is already decreasing in appeal is not clear to your representative.

ACTIVITIES OF THE FALL MEETING

The fall meeting was held in conjunction with the Conference on Manpower sponsored by the U. S. Office of Education on November 16, 17 and 18 in Washington, D. C. The major purpose of the manpower conference was to clarify some of the problems obtaining in the manpower situation and to make tentative proposals. The conference was attended by representatives of education, governmental agencies and the military. A copy of the report of the conference will be sent the members of the NARST as soon as it is available.

1. In the course of regular business Dr. Meister was unanimously elected to continue to serve as chairman, and Dr. Watson to serve as secretary.

2. The proposals of the manpower conference were discussed. It was decided that the Cooperative Committee could best serve the problem by preparing some publication or publications that would provide guidance to students on opportunities in scientific and technical employment. Three committees were appointed to investigate possibilities of publishing (1) a book, (2) a brochure, and (3) a series of articles.

3. Some extensive discussion was undertaken concerning scholarships opportunities for mathematics- and science-talented youth. The Cooperative Committee decided to recommend to various foundations and organizations providing such scholarships that the methods for locating such youth be improved and extended.

4. The status of the proposal for the National Commission of the Teaching of Science and Mathematics, financing of which is to be sought from the Ford Foundation, was discussed. In general, the attitude of the Cooperative Committee was that any proposals sould be refined further before presentation to the Ford Foundation.

Other matters of lesser importance may be found in the brochure.

FUTURE ACTIVITIES

On the invitation of Drs. Mayor and Sorum the next meeting of the Cooperative Committee will be held at the University of Wisconsin on May 2, 3 and 4; 1952.

At the Philadelphia meeting of the AAAS in December 1951 your representative was appointed to represent the Cooperative Committee on the Coordinating Committee for the Joint Meetings of the Science Teaching Societies Affiliated with the AAAS at St. Louis, Boston, and San Francisco for the years 1952, 1953 and 1954 respectively. The Coordinating Committee will meet in Chicago, Saturday afternoon, February 16, 1952. Any participation of the NARST will have to be decided at this meeting.

This report is presented for your approval.

OFFICIAL MINUTES OF THE BUSINESS MEETING OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING, CONGRESS HOTEL, CHICAGO ILLINOIS, FEBRUARY 16, 1952

President Betty Lockwood Wheeler presided at the annual business meeting of The National Association for Research in Science Teaching held in Parlor A, Congress Hotel, Chicago, Illinois on Saturday morning, February 16, 1952. The official minutes of the last business meeting held at Atlantic City, New Jersey, February 18, 1951, and published in the October, 1951, issue *Science Education* were approved as published.

The report of the Auditing Committee of the Treasurer's book was made for the committee by Clarence E. Baer, Chairman. Other members of the Committee were E. Laurence Palmer and Ralph K. Watkins. The chairman reported the Treasurer's books had been audited and found to be in balance. The report was accepted. Treasurer Clarence M. Pruitt then read the report as it will be published in *Science Education*. It was moved and seconded that the Treasurer's report be accepted. The motion carried.

The report of the Nominating Committee was made by Earl R. Glenn, Chairman. Other members of the committee were W. W. E. Blanchet and Clarence H. Boeck. The Nominating Committee presented the following slate of officers for 1952–53:

President: J. Darrell Barnard.

Vice-President: George Greisen Mallinson.

Secretary-Treasurer: Clarence M. Pruitt.

Executive Committee: Betty Lockwood Wheeler, Kenneth E. Anderson.

It was moved by Curtis and seconded by Bingham that the report of the Nominating Committee be accepted and that the Secretary be empowered to cast a unanimous ballot for those named by the Nominating Committee. The motion carried.

The report of the Barnes Membership Committee was read by Barnard. It was recommended by Barnes that the Committee be continued. Van Deventer moved that the report be accepted and the Committee continued. Bullington seconded the motion. The motion carried.

A report for the Publications Committee was made by Vaden W. Miles. Other members of the Committee are Wilbur L. Beauchamp and Charlotte L. Grant. It was moved and seconded that the report be accepted. The motion carried.

Dr. Curtis made a report for the Overall Committee on Research of the National Association for Research in Science Teaching. Other members of the Committee are Betty Lockwood Wheeler, Charlotte L. Grant and G. P. Cahoon. Certain recommendations were made by the Committee. The Committee will send to the Editor of *Science Education* for publication a tentative set of criteria (see report elsewhere in this issue), to serve directors of research in the teaching of science and others who have studies to report, as a guide to the selection of studies to be submitted for review. The Committee wishes to avail itself of the continued services of Dr. Philip G. Johnson of the Federal Security Agency in disseminating the outlines on which studies are to be reported and to receive the outlines and brief digests of the studies. These reports will be sent by the Secretary to the Chairman of the Overall Committee on Research in Science Teaching for review by all members of the Committee. The various Level Committees will receive selected studies that appertain to their respective levels. It is recommended that on the even-numbered years that the President and other members of the Executive Committee select a new member of this Overall Committee to replace a retiring member. It is further recommended that the Chairmanship of the Overall Committee be rotated annually.

The Committee expresses its willingness to continue to act in an advisory capacity to the Federal Security Agency and to such other agencies as may desire such services. Glenn moved that the report be accepted. Riedel seconded the motion. The motion carried.

Reports of the various level committees were then made. Bingham made a report for the Elementary Science Committee; Glenn for the Junior High School Committee; Anderson for the Senior High School Committee; Van Deventer for the College Committee; Barnard for the Problem-Solving Committee; and Beck for the Atomic Energy Education Committee. (Most of these reports are found elsewhere in this issue of *Science Education*). Hoffman made a motion that the various reports be accepted. Jensen seconded the motion. Motion carried. Bingham made a motion that the various committees be continued. Watkins seconded the motion. The motion carried.

A report for the Cooperative Committee was made by Mallinson. Boeck made a motion that the report be accepted. Miles seconded the motion. Motion carried.

Barnard presided during this part of the business meeting having to do with new business. Barnard asked for comments by members of NARST having graduate students at the meeting. All comments were favorable. Discussion then followed regarding next year's meeting place. No decision was reached and it was decided to ask members their preference by mail vote. Glidden expressed appreciation of West and Mid-west for meeting at Chicago. It was suggested that use of name label plates be continued. Van Deventer moved that a vote of appreciation of members for the inspiring and stimulating meeting be given the Executive Committee. Motion was seconded and carried. It was moved, seconded, and carried that President Betty Lockwood Wheeler be given a vote of appreciation for her excellent work as President during the last two years.

MINUTES OF EXECUTIVE COMMITTEE MEETINGS

February 14, 1952

Chairman of the various level committees met with the Executive Committee. Bingham was absent. Much discussion relating to a correct list of Charter Members resulted. Webb finally straightened the Committee out in this regard, showing that NARST members had reversed their actions at some of the earlier meetings.

Barnard made motion that Membership Committee be continued. Motion carried.

February 16, 1952

Barnard presided at Executive Committee meeting. Metzner, Beck and Reiner were appointed members of the Publications Committee. Discussion was held concerning better screening of proposed new members. There is also need of screening of papers presented at annual meeting. Curtis outline might be used in this process.

The following assignments of specific tasks were made by President Barnard:

Betty Wheeler is to assume the responsibility for keeping in touch with chairmen of level and special committees during the year. This is to be done in a manner that will encourage each committee to clarify its function, to develop the plans for achieving those functions, to activate members to carry out the plans, and to be ready with substantial reports of progress for next year's meeting. It was agreed that an early follow-up on the Chicago meeting would be desirable. Betty will be responsible also for planning committee sessions for next year's meeting. Betty, we'll depend upon you to get the Junior High School committee straightened out before Glenn leaves.

George G. Mallinson is to be responsible for planning the graduate-student sessions for next year's meeting. He will also be responsible for the dinner program and a "mixer" (probably without costly "spirits"). It was agreed that the business session would not be a part of the dinner program.

Clarence M. Pruitt and Kenneth E. Anderson will be responsible for the planning of the research-paper sessions. This will involve obtaining suggestions of papers from the membership, having abstracts (following the Curtis form) prepared, screening and making final selection on basis of criteria prepared by the research committee. This project should get under way not later than next fall so that final selection of papers to be delivered at next year's meeting could be completed by January 1 at the latest.

Clarence M. Pruitt will survey the members to determine time and place preferences for next year's meeting. This will be done after information regarding next year's ASCD and AASA meetings has been obtained. In a letter to the members, the pro's and con's relating to where and when next year's meeting should be held, will be summarized. A dead line for returning ballots will be set and Clarence will report returns along with his recommendations to the Executive Committee for final action.

Clarence M. Pruitt will submit by mail to members of NARST a revised roster of names proposed for membership. It was not clear to me whether only those names are submitted for whom two favorable references have been received. The constitution states that the Executive Committee nominates persons for election to membership. Holding for two favorable references may be desirable screening. What do you think?

It is my understanding that, in addition to the committees listed in our Chicago program (for which Betty is responsible) we have a Publication Committee (Metzner, Reiner and Beck) a Membership Committee (Barnes, Chairman) and a Research Committee (Curtis, Chairman). Furthermore, George Mallinson is the NARST representative on the Cooperative Committee and Betty Wheeler is NARST representative on the "Health Committee". I propose that Clarence assume responsibility for working directly with the Publications Committee; Kenneth Anderson with the Research Committee, George Mallinson with the membership committee, since one of this committee's jobs will be to study and come up with recommendations regarding graduate-student affiliation. If you consider it desirable at this time would each of you contact the chairman of your committee indicating in a tactful way that as a member of the Executive Committee and having responsibilities closely paralleling some function of that committee, you would like to assist wherever the chairman might find it desirable to use your services.

George G. Mallinson is going to have our stationery printed for the coming year. It is hoped that a place and date for next year's meeting can be settled soon so that this information can be printed on the stationery.

The following members were present at the Dinner Meeting in the Florentine Room on February 15, 1952 at 6:30 P.M.:

F. Atherton Riedel, W. L. Eikenberry, Clarence E. Baer, S. Ralph Powers, Francis D. Curtis, Hanor A. Webb, E. Laurence Palmer, G. L. Thiele, Ralph K. Watkins, Earl R. Glenn, Ira C. Davis (All Charter Members who were guests of NARST); Betty Lockwood Wheeler, J. Darrell Barnard, George G. Mallinson, Kenneth E. Anderson, N. Eldred Bingham, W. W. E. Blanchet, Milton O. Pella, Greta Oppe, G. P. Cahoon, Clyde M. Brown, Herbert A. Smith, Harley F. Glidden, Richard L. Weaver, Herbert S. Zim, E. Eugene Irish, John M. Mason, William B. Reiner, John A. Woodburn, Ralph W. Lefler, Thomas P. Fraser, Muriel Beuschlein, John H. Jensen, Charles W. Hoffman, Robert H. Carleton, Alfred D. Beck, Vernon C. Lingren, Robert A. Bullington, William C. Van Deventer, Philip G. Johnson, Vaden W. Miles, Helen W. Harvey, John S. Richardson, Clifford G. McCollum, Clarence H. Boeck, Hubert B. Crouch, Mary Alice Burmester, and Clarence M. Pruitt. There were also twenty quests present.

The mail vote on a meeting place for NARST in 1953 resulted as follows:

Atlantic City—30
Cleveland—24
Chicago—22
Detroit—11

Atlanta—1
St. Louis—2
National Science Teachers Association meeting place—2

Cleveland received 9 "No" votes, Atlantic City 6, and Chicago 5. On the basis of the above vote, the Executive Committee decided on Atlantic City for the 1953 meeting.

Respectfully submitted,
CLARENCE M. PRUITT, *Secretary*

REPORT OF THE PUBLICATIONS COMMITTEE

Papers given at the annual meeting of The National Association for Research in Science Teaching in Atlantic City, February 17–19, 1951 and presented to the Committee for publication were edited and submitted to the editor of *Science Education* for publication. Some of the papers appeared in the April, 1951 and October, 1951 numbers of *Science Education*. Only three papers have not been published. These will appear in *Science Education* in the near future.

Publications Committee,
CHARLOTTE L. GRANT
WILBUR L. BEAUCHAMP
VADEN W. MILES, *Chairman*

REPORT OF THE ATOMIC ENERGY EDUCATION COMMITTEE

Reports of the three sub-committees of the Atomic Energy Education Committee were read and discussed at the recent meeting of NARST in Chicago. The following recommendations, based upon the work of the past year, were made:

1. The use of the evaluation instruments in atomic energy education developed by Burnett and his associates * for evaluating existing curricular materials in this area and as a basis for constructing new materials.

2. Publicity should be given to recent bibliographies of materials on atomic energy education.**

3. Revision of "Introductory Bibliography on Atomic Energy".*** The committee recommends that this bibliography be revised along the following lines: a) organization of the material into three divisions; elementary school, high school sciscience and high school social science. b) Inclusion of selected curricular materials now in use. c) Simplification of the content classification; d) listing of charts on atomic energy; e) bringing the entire bibliography of curriculum materials, factual materials, visual aids, etc. up-to-date.

Our committee would welcome the opportunity to help in the task of revising this bibliography or parts of it.

4. Our committee should contact the Atomic Energy Commission at Washington, D. C. and suggest that there be prepared a listing of areas in Atomic Energy Education in which there are available speakers and that this listing be circulated among schools located near each atomic energy installation.

5. Design of a project calling for the creation of centers throughout the country which will house atomic energy educational materials of all kinds and either distribute some of the materials per se or evaluative statements on them to local educational institutions.

6. Publicity should be given to the idea that local colleges and universities constitute good sources for speaker services.

The following plans for the coming year were made:

1. A project, organized by Dr. John Richardson of Ohio State University, to

* Burnett, W. R., Gregg, L., Leeds, W. L., Lorbeer, G. C., and Peek, A. L. *Evaluation Instruments in Atomic Energy*, reproduced by Office of Education, Federal Security Agency, May, 1949.

** United States Atomic Energy Commission, *Selected Readings on Atomic Energy*, Washington, D. C., August 1951.

*** Light, Israel, *Introductory Bibliography on Atomic Energy*, Washington, D. C., U. S. Office of Education, Federal Security Agency, 1949.

determine the types of materials and activities on atomic energy that may be developed within various types of schools by pupils and teachers.

2. The preparation by the committee of a manual or handbook of demonstrations and laboratory exercises dealing with the fundamentals of atomic energy. An effort will be made to seek a sponsor for the publication so that it can be made available to science teachers at cost or without charge.

A "chain" letter has been prepared by Mr. Alfred Beck to be sent to NARST members and other interested parties. The responses to the letter will provide the basis for the manual mentioned above.

3. Some of the members of the committee will visit the Brookhaven installation. They will try to obtain from some of the atomic scientists suggestions for demonstrations on atomic energy which may be incorporated in our projected manual.

Atomic Energy Education Committee:

JEROME METZNER, *Co-chairman*
ABRAHAM RASKIN, *Co-chairman*
ALFRED BECK
GEORGE GLASHEEN
CHARLES HOFFMAN
PHILIP POWERS
JOHN RICHARDSON

REPORT OF PROBLEM-SOLVING COMMITTEE

Five members of the Problem-Solving Committee of NARST met in a work session in Chicago on Thursday evening, February 14. The Committee's bibliography of investigations dealing with problem solving had been revised during the year and the committee decided that its next step was to explore the methods of abstracting the investigations. As a first step it was considered desirable to prepare a standard form that could be used by the various members who had agreed to assist with the job of abstracting the investigations. During the work sessions twelve major questions were developed for inclusion in a preliminary form to be drafted by the chairman. The preliminary form will be tried out by several members of the committee and appropriate revisions made before it is released for general use. If the proposed abstracting technique works, it is hoped that meaningful reviews of investigations in problem solving can be published by the committee as a service to private teachers and research workers.

Submitted by,
J. DARRELL BARNARD, *Chairman*
Problem-Solving Committee

WHAT CONSTITUTES A RESEARCH INVESTIGATION IN SCIENCE EDUCATION?

The Overall Committee on Research of the National Association for Research in Science Teaching presents the following set of criteria for identifying research investigations in the teaching of science:

In order to be classed as a research investigation, a study must satisfy the criteria in one of three categories: A. Experimental studies, B. Analytical studies, or C. Synthetic studies.

A. *Experimental studies* include comparisons of learning under different methods or conditions of teaching and all other investigations that involve pupils in one or more types of learning situations. They are characterized generally by the following steps or techniques:

1. A statement of a carefully and specifically defined and delimited problem.
2. A thorough study of the literature appertaining to the problem, for the purpose of determining the need for the study and its possible contribution.
3. The development and use of an appropriate experimental design.
4. The collection of data and their treatment by appropriate statistical techniques.
5. A presentation of the findings and of the conclusions that seem justified by them.

B. *Analytical studies* are systematic attempts to determine from published materials, cooperating teachers, field studies, and

other sources such factors as the aims that govern or that should govern the teaching, subject-matter elements that are taught, the relative importance of topics, facilities needed for teaching, and the like. Analytical studies are characterized generally by the following steps or techniques:

1. A statement of a carefully and specifically defined and delimited problem.
2. A thorough study of the literature appertaining to the problem, for the purpose of determining the need for the study and its possible contribution.
3. A selection or invention of a technique appropriate to the problem and also one that provides means by which the validity and the reliability of analysis may be determined and maintained.
4. A presentation of the findings and of the conclusions that seem justified by them.

C. *Synthetic studies* are investigations in which various curricular materials, resource-use data, instructional suggestions, references, aids to teaching, and the like, are brought together into some unified pattern so as to be helpful in an educational situation. Synthetic studies are characterized generally by the following steps or techniques.

1. A statement of a carefully and clearly defined need or objective.
2. The development of criteria for maintaining selectivity in the use of materials and the consistent use of the criteria in thorough studies of materials appertaining to the need or objective.
3. The development of a practical pattern or technique for organizing the materials that met the criteria.
4. The preparation of a substantial publication that summarizes the results of the studies.

It is obvious that the foregoing types, or categories, of research are not mutually exclusive in all respects. Analysis often enters into studies that are primarily experimental. Certain types of synthesis may appropriately be a part of an analytical or a curricular study. Leaders in science education should attempt to judge the merit of each study that is completed and to report to the Office of Education on their prepared forms all studies that qualify as research under one of the three categories. Attempts should also be made to report all other studies that although not readily classifiable, are nevertheless thorough, substantial, and definitely constructive.

GUYBERT P. CAHOON
FRANCIS D. CURTIS, *Chairman*
CHARLOTTE GRANT
BETTY LOCKWOOD WHEELER

NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

FINANCIAL REPORT

February 14, 1952

RECEIPTS

Balance on Deposit	$ 954.60
Membership Fees	760.00
Total	$1,714.60

EXPENDITURES

Secretary	$ 44.47
R. V. Truitt—Convention Talk	25.00
Convention Recording Service	5.25
Social Hour—Chalfonte-Haddon	29.90
George G. Mallinson—Cooperative Committee	41.17
J. Darrel Barnard—NARST	1.80
Treasurer's Bond	5.25
Bank Charges	3.09
Science Education	792.00
Total	$ 955.53
Net Balance	$ 759.07

Respectfully submitted,
CLARENCE M. PRUITT,
Treasurer NARST

IMPROVING SCIENCE TEACHING THROUGH REALISTIC RESEARCH *

KENNETH E. ANDERSON

School of Education, University of Kansas, Lawrence, Kansas

Keeping Abreast of New Developments in Science

TEACHERS of science must keep abreast of new developments of science as a means of re-vitalizing their own information and understanding of science itself. For example, in chemistry, there has been a mushroom growth of processes involving ion exchange phenomena and it is only within the last three or four years that a nearly complete understanding of the mechanisms involved in the ion exchange process has been built up on the careful research of a number of investigators in the field.[1] The alert science teacher must be responsive to every such development to some extent. Although the teacher may not impart such gains in knowledge directly to his students, it furnishes a reservoir upon which to draw in synthesizing the parts of science into a meaningful whole. A teacher with the broad concepts of science in mind will, by virtue of this fact, help his students to develop a broad concept of science.

Research of an Educational Nature and Scientific Research

However, it is not enough to keep abreast of new developments in science. Teachers of science have long been concerned with developing effective teaching methods in their field. Out of the profuse literature concerning science instruction on the secondary school level, has emerged a fairly clear-cut body of objectives.

Mere lip service in regard to these objectives is hardly sufficient to produce a realistic program of instruction, which should (1) include continuous measurement and evaluation, (2) utilize those factors in the teaching situation which contribute most to student achievement of the objectives, and (3) demand rigorous research in and investigation of science teaching to the end that it might be improved. If science teachers were cognizant of the factors which contribute to student achievement, abreast of the current developments in science relative to the objectives of science instruction, and alert to the use of the findings of scientific and educational research, a more realistic teacher training program could result, increasing vitality in the secondary school science classrooms of the nation.

Rigorous research in science teaching demands continuous measurement and evaluation to the end that factors contributing to student achievement are isolated and used effectively in the teaching situation. Thus, science teachers should be concerned primarily with research of an educational nature but ever mindful of how the findings of scientific research can be incorporated with educational research. The two are not precisely the same in the strictest sense, but one cannot indulge in rigorous educational research without utilizing the elements of the scientific method and its associated attitudes. Therefore, science teachers should, by the very nature of their training, be producers of the finest types of educational research and possess at the moment the best methods of teaching, except that this requires an inquisitive mind and insatiable curiosity. If this were true, all teachers would turn to the science educator for counsel and advice. However, surveys have shown that this is not the

* Paper presented at the Twenty-fifth Annual Meeting of the National Association for Research in Science Teaching, Congress Hotel, Chicago, Illinois, February 16, 1952.

[1] William J. Argersinger. "New Developments in Chemistry of Interest to High School Teachers." *School Science and Mathematics* 50:107–111; February 1950.

case. May I quote from a study of science instruction in Minnesota schools?[2]

> Although the science teacher in 1946–47 was a younger teacher in terms of experience and a less highly specialized but more comprehensively trained teacher than the science teacher of ten and twenty years ago, the 1946–47 teacher showed weaknesses not in harmony with the objectives of science instruction and sound teacher training.
>
> The teachers as a group lacked an understanding of the scientific method. Once out of college they read few books on science or science education, and less than half of the teachers attended professional meetings. They were dependent in the main on manuals of the workbook type for laboratory instruction, although they used a variety of other procedures.
>
> While the teachers considered that development of skill in the use of laboratory apparatus was one of the chief functions of the science laboratory, it was encouraging to note that among the first ten functions listed were development of careful observation, understanding and use of the scientific method, scientific attitudes, and an understanding of science principles. However, the teachers had little to offer in regard to procedures for developing these more important functions of the science laboratory.

Therefore, the improvement of science teaching through realistic research looms more important as we are now in a position of a boot-wearer without the bootjack. Research then becomes a bootjack by means of which an improved science program can be effected. Whether or not research becomes an effective bootjack depends on whether or not the research tools available are used efficiently to some practical purpose.

Planning Investigations in Science Teaching

Objectives of Science Instruction

The principles of experimental design together with the golden rule that statistics must be brought into play in the advance stages of an investigation[3] are appropriate to research in science education, but these considerations will have to wait until certain basic points have been clarified. The first and most important question then becomes: What are we trying to measure or evaluate? Suppose we accept the thesis that our tests and examinations should cover many of the objectives of science teaching. This thesis gives rise to two suppositions: (1) that we have clear-cut objectives in science teaching, and (2) that we can measure these objectives not only in terms of rate and accuracy, but learning in terms of more important criteria of learning such as level of performance, permanency, and transferability.

Recent literature in science education contains many statements of objectives. However, these can be coalesced into four pivotal objectives: (1) acquisition of factual information in science, (2) understanding and application of the principles of science, (3) understanding and application of the elements of the scientific method together with its associated attitudes, and (4) skill in the basic tools peculiar to a specific science, for example, in chemistry the use of apparatus, ability to write formulas and balance equations, and to work problems based on formulas and balanced equations. These objectives are pivotal in the sense that they can be made by definition to include most of the more specific objectives of science instruction. Whether the science teacher agrees that these are his objectives of instruction depends in part on when, where, and what with regard to his collegiate training. For example, a teacher who has not experienced original investigation can be no more than a two-legged textbook. Such a teacher would not think of an understanding of the elements of the scientific method as a real objective of science instruction. Regardless of differences of opinion, we must have objectives to give direction to our teaching and to furnish a basis for the construction of an examination that possesses meaning or "makes sense" for the students under our tuition.

BUILDING A MEASURING INSTRUMENT

A useful aid in the construction of an examination to measure agreed upon ob-

[2] Kenneth E. Anderson. "Let's Face It." *Minnesota Journal of Education* 30:22–23; February 1950.

[3] Palmer O. Johnson. "Modern Statistical Science and Its Function in Educational and Psychological Research." *The Scientific Monthly* 72: 385–396; June 1951.

jectives is the test blueprint which allows us to build an examination so that each separate item occupies, as it were, a discrete position on a chart constructed with the objectives of instruction ranged along one axis and the course content or vehicle to achieve these objectives listed along the other axis. The availiability of a wide range of forms or types of items represents a third dimension against which each segment of course content and its related objective can be viewed to construct items in the most efficient manner. The test blueprint enables the test maker to: (1) achieve a representative sampling of course content and objectives, and (2) build equivalent forms for pre-testing and post-testing so useful in experimental design to control variation in acquired knowledge prior to the experiment, as well as practice effect from the beginning to the end of the experiment.

A discussion here of the common or garden variety of types of items available, their advantages and disadvantages, would be fruitful but time does not permit other than to say that ordinarily these types are designed to measure to a large degree facts or factual concepts of a low order. To get at the more important concepts or to rise above the mere testing of facts to more permanent learnings, one has to modify or adapt the usual form or type of item. To illustrate items that rise above the usual factual question and get at principles of science, may I quote from one examination?[4]

39. A storekeeper placed some calcium chloride between his sash and storm window during a severe cold spell. What happened?
    1. The window became more heavily frosted than the near-by windows.
    2. The substance became dry and powder-like.
    3. The calcium chloride evaporated.
    4. The windows remained almost free of frost.
    5. Nothing happened.
40. Which one of the following statements gives the principle that best explains the answer to question 39?
    6. Many gases such as water vapor and carbon dioxide can be solidified.
    7. Many chemical reactions depend upon the lack of or presence of moisture.
    8. Many solids such as dry ice and iodine pass directly from a solid to a gaseous state.
    9. Many substances readily lose their water of hydration or crystallization on exposure to air.
    10. Many substances have the property of absorbing or adsorbing moisture from air or other substances.

A type of examination item that gets at some of the elements of the scientific method provides experimental data and then asks the student to answer questions like the following:[5] (1) What factor or combination of factors was constant in experiment I? (2) What factor or combination of factors was varied in experiment II? (3) What factor in experiment III produced the observed difference in the amount of solute dissolved? (4) In these experiments what factors definitely affect the solubility of solids? These and many more illustrations show how one might go beyond the usual type of factual question, some of which are necessary in any examination.

Lest we get the idea that objective testing is the only answer to evaluation of science instruction, let us hasten to add that an important corollary of all instruction is the degree to which this instruction operates in the lives of boys and girls. Evidence of this kind is difficult to secure, but it is the "sin qua non" of evaluation.

No real science teacher would use a scientific instrument if he felt that it did not measure what it was designed to measure and did so reliably. Thus, if we are measuring current, we should not use a resistance box, for this is not a valid use of the box. The instrument is not measuring what it purports to measure. An ammeter is designed to measure current, and if it does so consistently, it is a reliable instrument. Also, the real science teacher would

[4] Kenneth E. Anderson. *Anderson Chemistry Test, Form Am.* World Book Company, Yonkers-on-Hudson, New York, 1950. p. 4.

[5] *Ibid.*, p. 6.

allow for error of measurement when using an instrument. Likewise, a real science teacher would not use an examination that did not possess validity and reliability.

Also the teacher would want an estimate of the error of measurement of an individual score. Thus, in educational research, where examinations must often be used, the ability to construct reliable and valid examinations in comparable forms with an estimate of the error of measurement and that sample both the objectives and content material of science instruction, is a must. This is not an impossible ability to acquire. Statistical evidence of reliability and validity, together with an error of measurement of an individual score, can be ascertained by most teachers with some statistical training. If the teacher does not possess this training, graduate work or self study can remedy the deficiency.

Experimental Design for Science Investigations

Having established, at some length, the necessity for examinations of a high order as requisite to educational research in science teaching, let us look at other necessary attributes of the science teacher wishing to do educational research.

In general, the findings of educational research should be based on an experimental design that allows the practitioner to apply the findings in many school situations. This can be done only if the experimental design provides a representative sample with which to conduct a self-contained experiment.

According to Johnson [6] and Fisher,[7] an experiment should be self-contained, that is, it should be capable of supplying genuinely independent evidence on any question in dispute, or capable of receiving a valid and unambiguous interpretation without reference to other experiments, or to the general body of experience previously available.

The first requisite of a self-contained experiment is the provision of a control which enables the experimenter to base all conclusions on the difference or contrast in the reaction of two similar bodies of experimental material or similar groups of experimental individuals, subjected to some accurately specified difference in treatment. The control or controls serve to exclude, at a known level of probability, a number of alternative interpretations of the experimental results.

A second requisite of a self-contained experiment is that the experiment must contain within itself the possibility of making a valid estimate of the experimental errors which actually affect the comparison made. A valid estimate of errors enables the experimenter to apply appropriate tests of significance fundamental to the interpretation of this result. A test of significance is a technical term applied to the process whereby the reliability of the data is examined.

The null hypothesis constituting the experimental hypothesis under test should be rigorously stated. The object of the experiment may be said to be to permit the facts of observation to refute the null hypothesis. The null hypothesis provides the basis for the application of the test of significance.

In proportion, therefore, as an educational experiment meets the requisites of a self-contained experiment and in proportion as it is representative of a particular class of schools or classes in science, can the findings of such research be applied with some degree of assurance that it will work in the present situation. Even, then, in true scientific spirit, checks should be made to ascertain that the method or device functions in the present situation.

Brownell [8] cautions research workers against the spurious appearance of simplicity and rigor in the control-group technique

[6] Palmer O. Johnson. *Statistical Methods in Research.* New York: Prentice-Hall, Inc., 1949. pp. 276–285.

[7] R. A. Fisher. *The Design of Experiments,* 4th Edition. Edinburgh: Oliver and Boyd, Ltd., 1947.

of experimentation. Almost all published investigations in which this technique has been used the advantage lies with the experimental group. The novelty of a new system of instruction may make it attractive to both teachers and students.

"In the last two decades developments in statistical method have lessened some of the hazards of control-group research. The values of recent statistical innovations are undeniable, for they provide a kind of direct control over factors not readily susceptible to direct control experimentally. Studies planned to take full advantage of analysis of variance and co-variance, for instance, have already demonstrated their worth. Everyone seems to be agreed that we want more rather than fewer such investigations. Yet, it would be a mistake to suppose that the control-group technique, bolstered as it now is by better statistical support, is the procedure for research on learning and on teaching." [9]

An understanding and workable knowledge of experimental design together with the necessary and appropriate statistical tools is an ability that science teachers should acquire if they wish to do rigorous educational research. Blind worship of the statistical method is not desired but an intelligent application of the tools of statistics is desired and advocated. To shy away from the statistical method because it involves some mathematics and an elementary understanding of the theory of probability, is to hide one's head in the sand and to continue to practice many of the unproved methods of instruction. An attitude which encompasses a completed world of knowledge—all is known—is to forfeit the scientific spirit of investigation and inquiry. We, as science teachers, cannot afford to maintain this position by the very nature of our training.

[8, 9] National Society for the Study of Education, *Graduate Study in Education*, pp. 59–63. The Fiftieth Yearbook of the National Society for the Study of Education, Part I. The University of Chicago Press, 1951.

Actual Investigations in Science Teaching

May I quote from two investigations which used the newer statistical techniques alluded to by Brownell?

"Because it is impossible in a limited space to describe with statistical rigor all of the factors found to be significant in pupil achievement, we will illustrate with one: the number of hours of laboratory instruction. When biology and chemistry classes in the upper one-fourth of the state distribution of hours of laboratory work received per year were compared with biology and chemistry classes in the lower one-fourth of the state distribution of hours of laboratory work received per year, the difference in mean achievement was statistically significant in favor of the classes in the upper one-fourth of the distribution.

The finding is more meaningful when we note that the pre-test knowledge and intelligence of the pupils were held constant, and that the examinations measured such objectives of science instruction as: acquisition of factual information, understanding of principles, and the scientific method together with its associated attitudes. Clearly, there must be more and not less emphasis on laboratory work!" [10]

"Thus, it was concluded that on the average and within the limitations of the experiment, the experimental group achieved significantly more than the control group on the formula writing test, holding constant the factors of pre-test knowledge and intelligence.

The results of this experiment have shown the value of the Sequence Method as outlined. Since the final test on formula writing contained formulas not previously written or memorized, there was evidence of transfer of training to new situations. It was contended that this took place because of greater understanding gained by using the Sequence Method.

Since formula writing is one of the basic skills of chemistry and since ability in formula writing must be obtained prior to equation writing and the solution of problems based on formulas or equations, the method which aids students to gain ability in formula writing should be used. The results of this experiment have proven the value of the Sequence Method as contrasted to the Traditional Method.

Although the writers recommend the use of the Sequence Method for high school chemistry classes, they do so only if the user re-evaluates the results of this experiment in his own situation. The user must prove the worth of the method in his own chemistry classes." [11]

[10] Kenneth E. Anderson. "Summary of the Relative Achievements of the Objectives of Secondary School Science in a Representative Sampling of Fifty-Six Minnesota Schools." *Science Education*, 34:168–176; April, 1950.

[11] Luther Melvin Colyer and Kenneth E. Anderson. "A Comparison of Two Methods of Teaching Formula Writing in High School Chemistry." *School Science and Mathematics* 51:50–59; January, 1952.

Application of Research Findings

It must be pointed out that the findings of the investigations which have been cited hold, strictly speaking, only for the schools or groups in which the experiments were conducted. If the investigations have been well designed and executed, one may apply the results to his own situation, keeping in mind at all times, that at the end, the application of the method or device should be re-evaluated in terms of your own situation. In other words, one should be reasonably certain that the results advocated by previous research accrue to some degree in the present situation. If examination proves this not be the case; either the previous research was erroneous, the method was not applied correctly in the present situation, or the conditions of instruction were such that the present situation was not in any way comparable to the situation in which the original research was conducted. In other words, one might well apply the findings of research, but with an attitude of reservation.

What of the Future?

If we, as teachers of science, are ever alert to the findings of scientific and educational research and the possible applications of the findings to our own situations, then and only then will science teaching be improved. May I offer the following recommendations for an improved program of science teaching and spirit of inquiry for science teaching?

1. A unified agreement on the objectives of science instruction. This does not mean that there could not be deviations in terms of local instruction or in terms of pupil ability and needs. It would be most desirable to adapt instruction to fit the community and the needs of its pupils.

2. A continuous program of evaluation of the objectives of science instruction. This would mean not only improved paper and pencil tests adapted to local conditions, but also measurement of an important corollary of all instruction: the degree to which it operates in the lives of boys and girls. Evidence of this kind is difficult to secure but it is the "sine qua non" of evaluation.

3. Increased emphasis on laboratory instruction. Students can gain real experience with scientific phenomena only in proportion as they deal with phenomena in a truly scientific manner, which means an increased emphasis on the method and spirit of science. This means much more than methodically following the steps in the scientific method. It means the solving of original problems rather than the repetition of experiments performed by scientists in the past.

4. Increased emphasis in teacher training institutions on sound scholarship in a broad background of sciences with actual experience in the use of the elements of the scientific method. A teacher who has not experienced original investigation can be no more than a two-legged textbook.

5. Sound techniques of developing within the student an understanding of the principles of science along with its method. This would include the proper use of the adjuncts to science teaching such as the field trip and the science club, as it is through these channels that students often do original work.

6. The development on the part of administrators and supervisors of an appreciation of the role of science instruction. Only in so far as faculty groups develop together a working philosophy for the school and community, will science instruction prove vital in the development of a fuller and richer life for boys and girls.

7. Increased emphasis on consideration of the individual student so that his needs and interests may be more fully met in science instruction.

Let us all who are teachers of science be interested in students first and science second; let us have a broad training in our

field and insight in the other branches of knowledge; and let us be militant for teaching as a career.

When we devote time and energy to increasing our knowledge of students and the methods and materials of science instruction, then and only then, will we have science instruction that will function in the daily lives of boys and girls. Can this be more than a fond hope?

NEEDED RESEARCH IN EVALUATION IN SCIENCE TEACHING*

WILLIAM B. REINER

Bureau of Educational Research, Board of Education of City of New York, Brooklyn, New York

WHAT research is needed in evaluation in science teaching? Whatever is taught should be evaluated and each part of the evaluation process requires continuous research. Curriculum, methodology, and evaluation are inseparably related parts of the instructional program. Each requires constant research and refinement. Each can help improve the other two. Evaluation research should result in the improvement of tests and techniques for assessing how well the aims of a curriculum have been achieved or how successfully teaching methods have been applied. In this article needed research in evaluation will be treated mainly in connection with curriculum considerations under the following headings: (1) General Problems, (2) General Objectives, (3) Special Program Objectives, (4) Testing Techniques, (5) Norms, (6) Validity, and (7) Reliability. Problems in need of investigation will be suggested and the discussion of each will of necessity be brief. No analysis will be attempted. In some cases overlapping of some of the headings given above will be found to be unavoidable.

I. GENERAL PROBLEMS

Most of the general problems stated below have been repeatedly raised in regard to the evaluation of science learning. They are very comprehensive and require a breaking down into constituent and subordinate operations. Such an analysis may yield several worthwhile studies from each problem. At any rate, these questions point in the direction of needed investigations. Each major question is identified by a letter of the alphabet and is followed by related subsidiary questions.

(a) What informal evaluation techniques other than tests and examinations can be used in assessing pupils' achievements of science course objectives?

1. How effective are such techniques as anecdotal records, pupil diaries, projects, and reports in measuring the achievement of various objectives?
2. How effective are they in assessing reasoning abilities?
3. How reliable, valid, economical of time, and practical are they?

(b) What tests and examinations other than the written or pencil-and-paper type can be used in evaluating science learnings?

1. What is the effectiveness of laboratory, object, or performance tests?
2. How can problem solving be assessed by laboratory or performance tests.
3. How can the validity, reliability, and objectivity of these tests be improved?

(c) How can self-testing by pupils be used in the evaluation program?

1. If pupils are permitted to plan curriculum experiences under the progressive class schemes, why not evaluation or testing experiences planned by them?
2. What testing materials other than pupil-scored check lists or pupil-submitted questions can be used?
3. What use can be made of mechanical or electrical teach-test boards where questions and

* Paper presented at the Twenty-fifth Annual Meeting of The National Association for Research in Science Teaching, Congress Hotel, Chicago, Illinois, February 16, 1952.

answers are mounted on a large board and where a bell, light, or slot indicates that a correct answer was given? (The Navy Department developed pinball game devices in World War II that were very effective. Science Research Associates developed a punchboard type answer sheet where the correct answer is indicated by colors as soon as the respondent makes a choice of an answer.)

(d) How can teacher-made tests be improved in regard to curriculum and syllabus validity?

1. How can their reliability and usability be improved?
2. How can regional pools of test items be established? This question should be studied by regional professional groups because most commercially published standardized tests are unable to cover all the areas of all the curricula throughout the nation. As a result there is frequently a loss in validity due to the pupils' lack of experience with some of the materials on the tests. An example of examination pools and exchange of information on test items has been reported in the *Journal of Chemical Education* for May 1948, page 280 in an article entitled, "The Testing Program of the Division of Chemical Education".

(e) By what means can we measure the influence of science education upon the social and personal behavior of the student?

1. What curriculum studies have been made that can suggest which objectives should be assessed?
2. What types of student behavior and activity would reveal that changes in social and personal behavior are taking place?
3. What techniques of assessment are best suited to measure the achievement of these objectives —questionnaires, inventories, or free response devices?

(f) How can tests be constructed to evaluate critical thinking, that are not too long, that do not require too much reading, that can be measured by objective scales, and can be machine scored?

(g) What practical, yet inexpensive devices for test scoring can be used to lighten the teachers' marking burdens?

II. GENERAL OBJECTIVES

Worthwhile objectives of science teaching have been stated in many yearbooks, reports, and studies. Efforts have been made to measure how well pupils have achieved the curriculum goals stated therein. Research is needed in the development and refinement of evaluation instruments in the accepted curriculum goals for three reasons. First, for some of these objectives, no acceptable instruments are available. Second, most of the evaluating devices have not been tried on large enough populations to be properly standardized. Third, periodic trial and revision are necessary to keep pace with the world events and curriculum adjustments. Many usable tests have been constructed in connection with doctoral or master's studies, particularly in the fields of scientific reasoning where few commercially published tests are available. Some of the aforementioned tests are usable, others offer rich suggestions for teachers interested in teaching and evaluating scientific reasoning and the "intangibles". The publication of these tests in professional journals such as *Science Education* would facilitate the wider trial and study of these tests provided, of course, the authors agree to their free non-commercial use. In brief, examinations and evaluating devices should be constructed, tried, and refined in connection with acceptable science objectives. The acceptance of the objective is but the first step in the process of developing an evaluation instrument. Some of these objectives are stated below.

(a) How can *factual* understandings be best evaluated?[1]

1. What techniques can be used to measure ability to predict outcomes in science problems, explain a phenomenon, judge the validity of a course of action, formulate a hypothesis, or evaluate sources of information?

(b) What instruments can be developed to measure *method* understandings?[2]

1. What techniques can be used to measure ability to make proper qualifications when interpreting data?

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[1] The Measurement of Understanding. Forty-fifth Yearbook of the National Society for the Study of Education, Part 1, Chicago; University of Chicago Press, 1946. Pages 104–37. L. M. Heil, P. E. Kambly, M. Mainardi, and L. Weisman.

[2] Op. Cit.

2. How can ability to identify unstated assumptions in conclusions be measured?
3. How can ability to recognize and use defensible arguments in justifying a conclusion, be evaluated?
4. How can ability to identify a valid cause and effect relationship be examined? (Excellent illustrative samples of questions for each type of objective are given in the 45th Yearbook quoted in connection with (a) and (b)).

(c) What techniques can be applied to measuring ability to apply a principle to the solution of a problem?

1. How can one measure the ability to recognize a group of situations as being samplings or applications of a given principle?
2. How can the ability to select the proper principle, from a group of several, that is applicable to the solution of a problem situation be measured?
3. How can the extent to which pupils apply principles of science to solve their personal-social problems be evaluated?

(d) What techniques should be used to evaluate ability to state hypotheses?

(e) How can ability to test hypotheses be measured?

(f) How can we measure ability to plan a "controlled" experiment or method of proof?

(g) How can the ability of pupils to think critically be evaluated?[3]

1. How can ability to distinguish between or recognize facts, theories, assumptions, inferences, opinions, and beliefs be recognized?
2. How can ability to distinguish between relevant and irrelevant ideas, competent and incompetent authorities, and facts and judgments be evaluated?

(h) What techniques can be used to measure pupils' scientific interests?

(i) How can scientific aptitudes be measured?

1. What use can be made of the analysis of reading interests and hobbies?
2. What simple performance tests can be used in connection with the above?
3. What tests of understanding and reasoning ability can be used?
4. Can adaptations of "projective techniques" be used? (The Westinghouse Science Talent Search Examinations are excellent examples of efforts being made in this direction.)

(j) How can scientific attitudes be evaluated?

1. What can be done to measure awareness in the pupil of desirable attitudes?
2. How can the pupils' knowledge of situations in which these attitudes are desirable or useful, be measured?
3. How can the tendency to act in a life situation be measured?
4. How can the various rating scales and techniques for measuring attitude be applied?
5. How can motion pictures and slides, which present more vivid and dramatic situations be used? (The Armed Forces have used a similar technique in indoctrination courses and for assessing reactions in problem situations.)

(k) How can study skills and work habits specifically applicable to science learning be evaluated? (The *Iowa Every Pupil Tests* and the *Tyler-Kimber Work Study Skills Tests* are very suggestive of what might be done in connection with science teaching.)

1. How can the pupils' scientific vocabulary be evaluated?
2. How can ability to sketch diagrams, interpret diagrams, read graphs, or locate scientific information be measured?

(l) How can we evaluate creative thinking in science relationships?

1. How can the ability to design apparatus and gadgets for certain problems be evaluated?
2. How can the talent for planning and developing a technique or method be evaluated?
3. How can the ability to suggest original hypotheses in novel problems be evaluated?
4. How can the ability to locate new problems be measured?
5. How can novel expression in the language, graphic, and other arts of scientific themes be evaluated?
6. How can the ability to combine known ideas into novel relationships or applications be evaluated?

III. SPECIAL PROGRAM OBJECTIVES

In the past decade, differentiation and specialization of courses and programs has taken place in response to the curriculum investigations which pointed out the need for them. It follows that the evaluation programs must be designed to meet the special objectives and testing problems pre-

[3] Self-evaluation in the Elementary School. Elementary School Bulletin #11. Trenton, New Jersey. New Jersey State Department of Education, 1946. Page 41.

sented by each type of curriculum. In programs such as the activity and core types which stress the personal and social development of the pupil, tests of informational recall are not enough. Measures of interest, aptitude, attitude, and critical thinking are needed, too. In the vocational and technical high schools special types of performance and object tests are needed in addition to the others.

On the college level, the general education program requires an evaluation of knowledge of the interplay of science, culture, commerce, and technology in the major historical periods. The survey course, the problems course, and the lecture-demonstration course have common ground and yet are given different emphasis in various colleges. Special evaluation adaptations must be made for these emphases. The technical or engineering course requires specialized examinations quite different in recall and mathematical skills content from the courses previously mentioned. Suggestions of needed research in science evaluation in these special programs is presented below.

There is a need to develop evaluative criteria in the newer programs for learning materials such as text books, apparatus, charts, models, visual aids in general, auditory aid materials, laboratory materials, live exhibits, and teaching techniques. Evaluative devices for these are needed for supervisory and teacher training purposes. In small schools, the teacher left to her own resources, should be able to evaluate learning materials and techniques if little or no supervisory assistance is available.

(a) What techniques are best suited for evaluating success in the recognized objectives of the activity program?

1. Should "readiness" tests be used in teaching science as they are in teaching reading?
2. At what point in elementary schools should systematic evaluation be undertaken?
3. How can science learnings be evaluated in a program in which science is taught in the context of general activities rather than as an isolated subject?
4. How can pupil-self-evaluation be used?
5. What techniques can be used other than written tests? How can oral tests, picture tests, or objects be used?
6. What objectives besides knowledge and interests should be evaluated with young children?
7. At what age levels do elementary school children show ability to reason about everyday life problems in science? Is there a difference with academic science problems?

(b) How can the recognized objective of the core curriculum be evaluated by means of presently available techniques?

1. What projective techniques can be applied to assessing science interests, aptitudes, and attitudes?
2. Shall science tests be constructed to measure knowledge of principles or shall they be constructed around the science information in the cores of life activities?
3. What correlations of achievement exist in tests of the same content but different context?

(c) How can science examinations suitable for vocational school programs be improved?

1. How can the test questions be written to test for applied information of the "how-to-do" type?
2. How can performance tests, object tests, and oral tests be used in vocational schools?
3. How can product rating of drawings and projects be employed to better advantage?
4. How can skills in manipulative processes be rated more efficiently?
5. How can self-evaluation of students be improved by means of self-kept progress charts?
6. How can outside work experience be rated more effectively in cooperative programs where students go to school and work part time?
7. How can curriculum validity be improved for the science courses preparatory for so many different vocations?

(d) What techniques and materials are best suited for the differentiated courses in science taught at the college level?

1. How can critical thinking be evaluated without asking verbose and extended questions that require unwieldy answers?
2. How can open-book tests be best applied to survey courses which cover large areas of information?
3. How can success in personal problems or adjustment courses be measured by other than pencil-and-paper tests?
4. What techniques are best applicable for evaluating knowledge, understanding, and critical thinking regarding the interaction of science and civilization? What are the proper objec-

tives of courses dealing with the history and influence of science?
5. What techniques are best for evaluating the accepted objectives of science in technical colleges? What means can be used to measure goals other than factual recall?
6. What techniques other than pencil-and-paper tests can be used in lecture-demonstration courses? How useful are term reports and pupil demonstrations for evaluating learning? How can the level and extent of pupil reading interest in science be assessed?
7. What are the proper objectives for survey-type courses and how can these be evaluated?
8. What is the relative effectiveness of the essay-type question and short answer question in assessing reasoning, understanding and application of relationships, and interpretation of relationships?

IV. Testing Techniques

The techniques used in evaluation are closely dependent upon the techniques used in teaching and for audio-visual aids. In colonial schools, teaching and testing were mainly of the oral type because writing materials were prohibitively expensive. Teaching and testing were concerned with the recall of factual information until broader objectives of reasoning and interpretation were introduced. Today our teaching materials and objectives are highly varied.

In considering needed research in the testing techniques in science, the more recently adopted teaching practices and media of communication must be considered. Slides, motion pictures, radio, and even television are available to many schools. If they are used for teaching they can be used in testing. Medical schools use television in teaching surgery. New York City schools, amongst others, have used radio broadcasts in teaching and have developed pencil-and-paper tests based on the content. The Armed Forces have used motion pictures in identification and problem tests. The effectiveness of these techniques needs to be determined by further investigation and research.

A major difficulty in measuring reasoning skills lies in the large amount of reading matter given in the premise of each question. Poor readers in high school or college find this a severe handicap. Slides and motion pictures may possibly eliminate this handicap. Pictures and diagrams may prove to be helpful, too. The use of graphic art in presenting data should be studied also in relation to testing.

Techniques involving self-rating by pupils and the evaluation of products and processes are in need of further study. In science, much of the teaching involves products and processes. Special types of tests will be discussed in the last section of those which follow.

(a) How can the modern media of communication be used as parts of testing and examination techniques?

1. In what situations is the use of motion pictures most effective for testing purposes?
2. What use can be made of television in testing programs?
3. How can radio broadcasts be used in testing programs?
4. What use can be made of film strips and lantern slides in testing programs?
5. How can tape-recorders, wire-recorders, or phonographs be used in testing programs?

(b) How effective are certain graphic art techniques for presenting data in written examinations?

1. How may pictures and cartoons best be used in writing test items for poor readers? How effective are they for better readers?
2. How effective are diagram completion and diagram labeling as testing devices for poor readers? How effective are they for better readers?
3. Of what value are graphs, tables, and flow charts in presenting data in tests of reasoning and interpretation?

(c) What is the effectiveness of self-rating techniques? In what curriculum areas are they of most value? At which maturity levels are they most effective?

1. How can the anecdotal record be used in science evaluation?
2. How useful is the pupil diary or log in science evaluation?
3. In which activities are self-rating scales and check lists most useful?
4. Of what value are interest inventories and personal problem inventories in relation to science?
5. How reliable and effective are self marking devices? (C. C. Ross, in *Measurement in Today's Schools,* page 357–8, mentions several such devices.)

(d) How can techniques be refined for evaluating the products and manipulative processes involved in science learning?

1. What rating scales can be used in evaluating pupils' projects in elementary science? Models, care of pets, collections, charts, and home-made toys are but a few examples of projects on which young pupils can work.
2. How can laboratory skills or pupil demonstrations be evaluated? (Excellent studies by Ralph Horton in chemistry laboratory skills, by R. W. Tyler in microscope techniques, and by R. O. Beauchamp and H. A. Webb on general laboratory resourcefulness are worthy of careful study by future researchers.)
3. How can techniques be refined for testing pupils' abilities to identify objects, apparatus, microscopic slides, charts, chemicals, geologic specimens, and living specimens in various science studies?
4. How can techniques be refined for testing pupils' abilities to identify and understand basic processes and operations in various science areas? (Mitosis, distillation, filtration, osmosis, and capillary action are but a few samples that can be used.)

(e) How can improvements be made in the construction of certain specialized types of tests?

1. How can open-book tests be better employed in tests of reasoning and interpretation? (With information available to the students, more attention can be directed to having them find relationships and integrations.)
2. What is the relative value of the open-book test techniques reported by investigators?
3. How can open-book tests be best employed in the activity and core programs?
4. How effective are oral or interview tests compared with written tests in connection with evaluating the work of elementary school children, slow learners, poor readers, and secondary school pupils?
5. What use can be made of readiness tests in the teaching of elementary school science? Are there skills and concepts that children should master before learning can proceed to higher levels? If so, what are these "readinesses"? What are the higher levels?
6. How can diagnostic tests be refined in the teaching of the sciences? What areas of physics and chemistry, particularly those involving calculation and the application of principles, are most in need of diagnostic tests? How can diagnostic tests best be used in the teaching of certain areas and levels of science?
7. How can examination questions and techniques be pooled by teachers, schools, or districts? How can tests be co-operatively constructed by schools working with research agencies in school systems or colleges?
8. What improvements can be made in the format and in arrangement of the printed or reproduced matter of tests, scales, and examinations? Is there a best arrangement for certain types of questions? Is there a best arrangement for certain age or grade levels? How can the task of marking test papers be lightened for the classroom teachers?

V. NORMS

A norm is an experientially derived index which enables teachers to compare the achievements of their pupils with those of other pupils of similar age or grade. To determine the norms for a test requires the cooperation of many schools in administering and scoring the tests. Much more research of the "action" or cooperative type is needed in order to improve the usefulness of test norms in making the interpretation of pupils' test scores more meaningful to the teachers and supervisors using them.

Periodic revision of norms is necessary because of the variability in passing years of courses of study, of curricular emphasis on certain areas, and of standards of difficulty. In some instances, presently used norms were obtained from pupil samplings which were academically more select than those of 1952.

A norm is assumed to be the average achievement of an average pupil, in an average sized school, receiving an average quality of instruction from an average teacher, who is teaching the average course of study. How about the pupil of low I.Q. or the vocational course student? Do the norms apply to them as well?

Several problems in connection with norms are in need of further research and are indicated in the questions which follow:

(a) How can norms be derived for standardized tests given to pupils in specialized courses?

1. How can norms be derived for science tests given in industrial or vocational courses?
2. How can norms be derived for core or experience curriculum pupils?

(b) Should separate norms be derived for pupils of low I.Q.?

1. Would adjustments in norm values, in terms of I.Q. or Mental Age points, be practical?

(c) How accurate are the norms of various tests in science subjects, particularly those norms which have not been checked in the past ten years?

(d) How can age, grade, and percentile norms be made more meaningful for interpretive purposes?

(e) How can norms be made flexible so as to take into consideration differences in curriculum content?

(f) How can norms be established for tests other than written ones? Can norms be established for performance or oral tests?

(g) What techniques can be established for insuring that adequate population samplings are used in establishing norms in science tests?

(h) How can national norms, regional norms, and local norms be established for various tests in science?

(i) How close is the correlation between norms of tests designed for similar subject areas and pupil populations?

1. How can norms be compared from test to test and for the different age and grade levels in each test?

VI. VALIDITY

A test or examination or any evaluating device is valid if it really appraises what it is designed to appraise. Validity is considered to be the most crucial quality of a test by authorities in the field of measurement. Unfortunately, some authors make unwarranted claims about the objectives that their tests can measure. This is probably due to an insufficiency of experimental trials. Practical research can be carried on to advantage in checking the various types of validity of the published tests used in science education.

A major problem in curricular validity is presented because courses of study, syllabi, textbook, and class activities vary so widely from city to city and even in different schools of the same city. Are comprehension and skill being measured with validity if tests contain many items which were never studied by the pupils being examined in a particular school?

The statistical validity of a test is obtained by comparing how closely the achievement score on it correlates with a closely related skill or trait. If a group of pupils who are rated high by their teachers in chemistry, have high intelligence ratings, and score high on standardized chemistry tests, are unable to make good scores on a chemistry test designed for their age, grade, and ability levels, then such a test may be suspected of being invalid. It is possible to obtain a measure of correlation with each criterion mentioned above and on this basis express an index of validity for the test. The internal validity of each item on the test can be found by comparing the success of each pupil on each separate item against his score on the test as a whole.

Research in the aspect of validity of science examination would be of most value if it were of the action or practical type. It would be concerned mainly with checking on the tests already published or about to be used for various projects. Some suggested problems are given in the paragraphs which follow.

(a) What techniques can be used to check on the curricular validity of an examination?

1. How can the curricular validity of examinations be improved?
2. Can the degree of curricular validity be expressed by means of an index or statistical term so that it can be expressed with objectivity?
3. By what manner can curricular validity be measured in non-subject matter areas such as attitude, reasoning, and interest?
4. If continuous curriculum revision is necessary, how can a parallel process of checking curricular validity be employed?

(b) What standards of curricular and statistical validity should be expected from a science examination?

1. How valid are some of the older examinations?

2. How valid are published tests in specific subjects for vocational school pupils?
3. How valid are certain tests for pupils of lower intellectual ability?
4. What effect has the size of a school or its socio-economic status on the validity measures?

(c) What problems in validity are presented to the test construction experts by the advent of the core curriculum?

(d) What procedure can be developed for enabling examiners to select only those test items which have curricular validity for the group being tested?

1. Can a means be developed for calculating the statistical validity of an examination from which certain test items have been omitted?

(e) How closely does the opinion of teachers in regard to the validity and suitability of test items correlate with the obtained statistical indices of validity?

VII. RELIABILITY

The reliability of an evaluation device is the consistency or sameness with which it measures its objectives. While reliability is a major criterion of a good examination, it is meaningless unless examined together with the validity measures. To give a mechanical analogy—a scale may be consistent in recording a 5 pound weight as 3 pounds at every trial. Yet, this scale is defective. Unless some cross check is made on another scale, the weigher may be misled.

Reliability is expressed as a correlation between the scores of two different trials of the same test given to the same individuals. Where it is not possible to administer the test this way, the scores of "chance-halves" of one test are correlated against each other. The "footrule" coefficient of reliability can be calculated from the mean, number of cases, and standard deviation of the test scores of a distribution by employing Kuder and Richardson's formula.[1]

"Action" or service type of research would probably be of most use in the area of studying the reliability of tests in science education. Data regarding old tests and newly developed ones could be gathered and pooled by interested professional groups. Some of the questions suggested for study in connection with reliability measures are presented below.

(a) How reliable are tests of objectives other than informational ones such as interpretation of data, testing conclusions, suggesting hypotheses, or recognizing cause and effect relationships?

1. How can the reliability of tests of the "intangibles", or objectives other than information, be improved?
2. What methods of testing reliability can be developed, on a simplified basis, for the classroom teacher?

(b) How can the reliability of evaluating devices other than paper and pencil tests be improved?

1. How can the reliability of performance tests, object tests, rating scales, anecdotal records, and self-rating devices be improved?

(c) What is the effect on the reliability of a test in science of varying the types of test items used in measuring the same objectives?

1. How effective are completion, multiple-choice, true-false, or association types of questions in raising the reliability?
2. Do essay types of questions or short-answers-with-reason-for-choice yield higher reliability measures?

(d) Do pupils of various age or ability levels give more reliable test results when the test items are of certain types?

1. Do pupils of low intelligence give more reliable test results on association types or fill-in-recall types of items?
2. How reliable are picture tests with young children?
3. How reliable are open-book tests with older children?
4. Will the same test give the same reliability data with very bright as with slower pupils?

(e) How does the reliability index of a science test correlate with the reading ability of the group tested?

(f) How can the reliability of self-rating devices, such as check lists, be improved?

[1] G. F. Kuder and M. W. Richardson, "The Theory of the Estimation of Test Reliability", (Formula 21). Psychometrika, 2:151–160; September 1937.

(g) To what degree is the reliability of a test affected by including curriculum units that have not been studied by the class?

(h) To what extent is the reliability index of a science test affected by the previously studied science courses of the students taking the test?

VIII. CONCLUSION

A great deal of research remains to be done in evaluation in science teaching. Evaluation is broader in scope than measurement or testing. Problems in science evaluation, some new and many old, were presented in connection with objectives in learning. Special programs such as the activity and core types present new problems. Evaluating pupils of various age and ability levels present both new and old problems. Testing techniques, norms, validity, and reliability require study and experimentation.

The problems presented above are by no means a complete or exhaustive compendium. Neither are they all very important. It is hoped that their somewhat systematic presentation will suggest research studies to interested students and their sponsors. It is also hoped that a newly gained insight into the inherent difficulties of test construction will make test users more alert to the weaknesses that may be found in some standardized tests, and will perhaps encourage them to prepare evaluating materials more suited to their own use.

Research in science evaluation requires the writing of tests, their use, and a careful analysis of the obtained results. This is a very laborious project and is best accomplished by committees pooling and sharing resources of information, talent, and secretarial help. Professional organizations and testing bureaus of colleges and public school systems have sponsored and assisted in such research in the past. It is to be sincerely wished that more of this can be encouraged, for evaluation is indispensable to and inseparable from the teaching process.

BOOK REVIEWS

WHITBREAD, JANE AND CADDEN, VIVIAN. *The Intelligent Man's Guide to Women.* New York: Henry Schuman, Inc., 1951. 167 p. $2.75.

This book may be characterized as an atomic explosion directed against men. The authors happen to be married women, each with three children and happily married women by all implications. Yet what they say about poor, sophisticated, egotistical man will more than make his ears burn—he should want to crawl into a cave and emerge only on dark nights. It is said that the two authors are not even feminists—but one wonders. At any rate they maintain that the American man has high standards for everything except marriage. But here again in this premise the authors are, in all probability, wrong. Man has high standards in very few things, if any!

Written with the head and the heart (?), occasionally with tongue in cheek, this book will cause the reader to laugh, chuckle and gasp with surprise. The authors, writing wittily, irreverently and amusingly, offer the first full scale picture of the American woman as she really is—the woman he lives with, talks with, eats with, and sleeps with, but hasn't any notion of what makes her tick. This is an enjoyable book for any man (or woman) who admits he does not understand women or falsely assumes he does!

MONTAGU, ASHLEY. *On Being Intelligent.* New York: Henry Schuman, 1951. 236 p. $2.95.

On Being Intelligent is a sort of companion book to *On Being Human,* regarded by many persons as one of the most distinguished books of the last decade. *On Being Intelligent* will receive similar acclaim. It is a book that should help its readers steer clear of the swamps of frustrated and irrational living, showing that if life seems unsatisfying the fault generally is not in ourselves, nor in our stars. Professor Montagu believes that the fault is in our approach to the social and cultural atmosphere in which we are nurtured.

On Being Intelligent should give you a mental X-ray picture of yourself; it should help you

to see when you are acting out of prejudice; how to weigh what you read and are told; how to deal with the saleman of spurious ideas; how to handle your dangerous impulses; when to express your emotions and when to control them; how to avoid *psychosclerosis*—hardening of the mental arteries; how to attain mental security; in brief, *how to live intelligently.*

Altogether this is one of the most stimulating, thought-provoking books one is likely to chance across in a long while. The reviewer thoroughly enjoyed it and highly recommends it to readers of *Science Education.*

WYLER, ROSE. *Planet Earth.* New York (20 East 70th Street): Henry Schuman, Inc., 1952. 156 p. $2.50.

This is the story of the earth as the abode of life. Much from the fields of astronomy and geography is interwoven into a delightfully told story of the only known inhabited planet in the whole universe. The earth truly leads a remarkable existence in the vastness of space. The author relates the story of the earth as a member of the solar system, its relation to the other planets, the moon, the sun, our galaxy, and the whole universe itself. The story of the *Planet Earth* is also a story of how men have tried to understand the world, their discoveries, investigations, inventions, and innovations. Men have learned much about the earth—its size, movements, relations to other heavenly bodies, gravity, weather, atmosphere, inside composition, and so on.

Elementary science and general science teachers, and pupils will find the book written in an interesting, readable literary style, with accuracy checked by some leading authorities in science.

Miss Wyler is wellknown to many readers of *Science Education,* and is an elementary science teacher and consultant of many years experience. She is presently associated with the Downtown Community School in New York City.

MARTIN, EDWIN T. *Thomas Jefferson: Scientist.* New York (20 East 70th Street): Henry Schuman, Inc., 1952. 289 p. $4.00.

Few Americans have had as extraordinary range of interests as did Thomas Jefferson. His intellectual travels took him all over the world of knowledge: law, government, medicine, agriculture, architecture, languages, literature, education, music, philosophy, religion and almost every branch of the natural sciences from astronomy through meteorology to zoology.

The author states that as a scientist, Jefferson displayed the same extraordinary versatility: "it is partly to Jefferson that America owes its decimal coinage, its weather bureau, the early adoption of vaccination, the establishment of scientific societies and museums—as an inventor he designed an improved plow, a swivel chair, a camp stool, a portable desk, a collapsible ladder—with remarkable insight he foresaw the development of aviation, of submarines and torpedoes, of mass production through standardised parts."

It is said that of all things that Jefferson did in the course of his long and busy life he enjoyed his scientific activities most. In this book Professor Martin of the English Department of Emory University unfolds this dramatic, fascinating story that has never been completely told before. As one reads this unusual book about a not too well known facet of Jefferson's life, one is reminded of another man of broad and varied science interests and knowledge better known as an artist, Leonardo da Vinci. Truly Jefferson was an outstanding scientist whose better known accomplishments in other fields has served to obscure his important ideas and contribution to science. This book is highly recommended for the library science shelf.

RIEDMAN, SARAH R. *Water for People.* New York (20 East 70th Street): Henry Schuman, Inc., 1952. 151 p. $2.50.

This is the story of man's use of water, how it came to be, how its specific properties make life possible, how water is used, and the future of water for human usage. A number of single experiments with water are described.

This is an accurate, authoritative, elementary science book for pupils and teachers and also general science pupils. It is an excellent book as a resource reference for either a study of water or conservation. The author is a science teacher at Brooklyn College. She is also author of *How Man Discovered His Body.*

PEATTIE, ROD, AND LISA. *The City.* New York: Henry Schuman, Inc., 1952. 108 p. $2.50.

This book tells how cities first came into existence, how they grew, and what happened to some of them. At first there were no cities, not even villages. Then for a long time there were just villages. Finally, cities grew up on the site of old villages.

The authors picture and describe the life of cities from ancient times down to the present. A major theme is that life in the cities meant freedom. Without cities there probably never would have been freedom. Modern cities are the biggest and most complicated thing man ever built.

Elementary, junior high, and senior high school science and social studies teachers will find this a different, interesting, challenging story of cities. Teen-agers will enjoy the book both as a description of the way cultural life, and even freedom itself, began and developed in a city. Here are indicated community problems both interesting and challenging to the pupil and teacher.